ROADS AND STREETS

A Gillette Publication—Established 1906

Vol. LXXVII *Chicago, February, 1934* *No. 2*

Tennessee Valley Road Job COMPLETED IN RECORD TIME

Contract Including 160,000 *Cu. Yd. Earth Excavation,* 30,000 *Cu. Yd. Rock Excavation and* 58,000 *Sq. Yd. Reinforced Concrete Pavement Finished in* 69 *Days*

SETTING the pace for road builders for the "New Deal," W. W. Boxley & Co., Roanoke, Va., has completed work on the Norris Dam-Coal Creek road. The contract called for completion of work 69 days after award of contract. This required 160,000 cu. yd. of earth and 30,000 cu. yd. of rock excavation along the 4.8 mile highway, and the placing of a 10-8-10 in. section of reinforced concrete surfacing 22 ft. wide, totaling 58,000 sq. yd. Other work included 5,000 cu. yd. of borrow, 500 cu. yd. of earth excavation for structures, and 550 cu. yd. of concrete in culverts.

First announcement of the proposed road was made Sept. 28. Bids were received by the TVA Oct. 27. Award of contract was announced on Nov. 1, and the contract was completed on schedule.

Materials to be used in construction of Norris Dam will be transported over the road. Late it will form part of a scenic highway through the Tennessee Valley.

Because of this, a 250 ft. right-of-way is provided, to be landscaped according to the new standards which have been established for roadway development—retaining the natural beauty of the country through which the road passes. This will require planting of any native trees and shrubs, prohibits billboards and unsightly roadstands, and requires approval of plans for automobile service stations.

The route selected leads through a rugged region of unusual beauty and the new highway winds around the mountain to present an almost continuous panorama of beautiful scenery.

The highway will connect with the top of the Norris Dam at the west abutment. A roadway will be built across the dam, which in turn will connect with another scenic highway that the Tennessee Valley Authority will

Grading Highway Through the Rugged Country Leading to Norris Dam

Paving Operations on the Norris Dam-Coal Creek Road

build in cooperation with local authorities of Knoxville.

To complete this project on schedule, 320 men were worked three shifts each day, seven days per week. The equipment on the job consisted of one paver, six shovels, six steam rollers, eight tractors and bulldozers, and two graders.

Temperatures during a considerable amount of the paving made it necessary to provide some protection to the concrete slab. This was accomplished by the use of canvas frames under which lighted lanterns were placed at brief intervals.

J. W. Bradner was engineer in charge of construction.

▼

A Laboratory Traffic Test for Low-Cost Road Types

The U. S. Bureau of Public Roads has recently built and placed in operation at the Arlington Experiment Farm a small circular test track for applying, in the laboratory, traffic tests to sections of highway surfaces. The test was designed primarily for the study of low-cost bituminous types, but it is believed that it may be adapted for other studies such as, for instance, subgrade stabilization, motor-vehicle tire wear, etc.

The track consists of an annual concrete trough 12 in. deep, 18 in. wide, and 12 ft. in diameter at the center line. The depth is sufficient to permit the use of various combinations of base materials beneath the bituminous test surfaces. Along the smaller circumference of the trough in which the test sections are held, and cast integrally with it, is another trough 3 in. wide and 13 in. deep intended to be used as a reservoir for the introduction of water into the base material under the test surfaces through small openings at the base of the partition wall. By this arrangement the track may be flooded or the water may be introduced through capillarity.

Two full-size automobile wheels provide the traffic for the tests. These wheels are fixed to the two ends of a rigid structural member which is rotated in a horizontal plane by a vertical shaft in the pedestal at the center of the track. The upper end of this shaft is squared and on it rides a freely sliding square nut mounted in trunnions in the cross member. This arrangement causes a constant wheel load (that due to the weight of the wheels, tires, and cross member) to be applied at all times regardless of the irregularities of the test surfaces. At present this load amounts to about 800 lb. per tire. Although the distance between the two test wheels is fixed, a handwheel adjustment is provided which shifts the position of the square nut with respect to the midpoint of the cross member and enables the operator to place the path of either wheel at any point on the test surface.

An electric motor operating through a 3-step cone pulley and a worm reduction drives the vertical shaft at the center of the track.

The test wheels may be operated at speeds of 4½, 6, or 9 miles per hour as desired. The low speed has proved to be most convenient when distributed traffic for compacting the surface is required. For the testing of the completed surfaces, concentrated traffic and the highest speed are used.

The number of trips made by each wheel is recorded by an electrical contact mechanism on the central vertical shaft operating a magnetic revolution counter at a point outside the track. In addition to this record, the data being collected include the corresponding behavior of the material under test, the density of the surface before and after test, oil migration, water content, and amount of material lost due to raveling. It is hoped that this information will make possible the evaluation of the important factors affecting the behavior of oiled aggregate mixtures.

The apparatus is now being used to investigate the effect of the percentage and consistency of the bituminous material on the durability and stability of mixtures with one type and grading of aggregate. A later phase of this first series of tests will involve a study of the effect of capillary water on the same mixures. Various other factors influencing the behavior of different types of bituminous surface will be studied.

From the preliminary work which has been done up to this time it appears that the apparatus will provide a very useful method of studying some of the many factors involved in the performance of low-cost bituminous surfaces.

The Highway Balance Sheet

A Comparison of Highway Costs With Highway Earnings

By R. W. CRUM

Director, Highway Research Board, Washington, D. C.

THERE is no question but that the pattern of highway development in this country is changing, just as the whole economic structure in the United States is changing.

It has been said so often of late, and constantly reiterated, that the time has passed when roads will be built just because the people want and can afford them, and that from now on highway development must depend on economic justification, that there is no need for me to spend time discussing that obvious fact.

Let us just grant that this is the case and go on to the next step. The question is: What shall we do about it?

The answer right now is that we are greatly handicapped in doing anything about it by lack of exact information concerning the facts of the situation. So I suggest that one important thing to do is to go to work to ascertain the facts as to highway costs and highway earnings as rapidly as possible.

Before the most convincing arguments for continued highway development and against diversion of funds collected from highway users can be formulated, the relation between costs and earnings in specific cases and for the country as a whole must be examined.

This is by no means an attempt to solve the whole problem of highway economics, but the relationship between costs and earnings is indubitably a basic factor and constitutes one corner of the puzzle, the assembly of which will greatly facilitate putting the rest of the pieces in their proper places.

The Problem Complex.—There has been much talk about the seriousness of the situation, but little has been said about what the road builders, engineers and administrators should do to help guide developments into proper channels. I expect the difficulty lies largely in the immense complexity of the problem and our proneness to want to put the whole jig-saw picture together in one grand operation. The attempt to visualize the whole picture at once has already given me mental indigestion, so I have decided to concentrate my thoughts on one corner and see if we can't proceed from there toward a larger area. The corner that I have in mind is composed of fairly definite elements and I think they can be assembled.

The whole problem of the value of continued highway development involves appraisal of all benefits derived from highways to the country as a whole, or to its citizens. Studies of the possible benefits from highways as a part of the national transportation system by air, road, rail and water should be made, and also some way should be found to appraise the social benefits that have resulted from the making of personal transportation so universal and economical. But at this time I am only advocating the study of the relation between highway costs and highway earnings in a strictly utilitarian sense, and I will further restrict it to consideration of those highways that are so generally used for transportation purposes that their function for giving access to the land is relatively unimportant; these are the so-called "General Use Roads."

Highways as Public Utilities.—The systems of these highways in the several states, in fact, constitute public utilities owned and managed by the public, and their complete engineering valuation as such should ultimately be made in all governmental jurisdictions having charge of a general use highway system.

However, at this time I am not even going into all of the various ramifications of public utility valuations as related to highways. I merely want to call attention to the desirability of starting by studying one phase of valuation studies, namely, comparison of annual costs of providing highway service with the earnings of the systems as collected through motor vehicle license fees and taxes upon fuel. If we can get that much of the picture assembled, a great deal will have been accomplished. The rest of this paper, therefore, will be devoted to this one phase of the subject; a comparison of highway costs with highway earnings, or a "highway balance sheet."

The proposal is simply this:

Compare the annual cost of a given highway system with the amount of revenue derived from the traffic using that system. The comparison can be made with past

A Highway in Southern California

annual costs to see if expenditures have been on a sound basis; with current annual costs, or with the estimated costs for the system in some improved condition. Any of the comparisons are bound to be illuminating. Such studies can be most readily made upon the state highway systems of the several states.

Although the plan is simple in theory, it must be admitted that there is considerable effort involved in working out the details and some questions are sure to arise that need to be answered before starting. Hence some elucidation of the major steps involved in the process is desirable.

Annual Costs.—The annual cost of a highway system is the amount required each year to keep it in standard serviceable condition, plus interest on the investment.

Before considering how it can be determined, it may be well to call attention to the distinction between annual cost and financing. In making arrangements for financing an investment in general use roads, the sources of funds are usually direct taxation, bond sales, and in some cases, contributions by the Federal Government. The making of these arrangements is a necessary feature of highway administration, but these various funds do not figure as such in computations of annual costs. Our interest in them in this connection lies only in the proper interest charge for their use.

Theoretically, the average annual cost over a long period of time as shown by the Committee on Highway Transportation Economics of the Highway Research Board[1] consists of the interest on the investment, the annual maintenance charge, the annual cost of administration, and the annual sums of money necessary to be set aside to produce the right amounts at certain intervals for periodic maintenance and restoration. The true annual cost of a highway or system of highways might be determined in this way for an indefinite time in the future if our estimates of the amounts needed for restoration at periodic intervals could be correct.

In view of our inability to foresee conditions very far into the future, the most practical method of estimating annual cost will be to limit ourselves to a definite time of reasonable extent. In most cases twenty to thirty years will be as far ahead as we can expect to make reasonable good estimates of future needs. On this basis the annual cost will include the known items of expenditure, plus an annual allowance for depreciation. The term "depreciation" in this discussion includes not only physical deterioration, but obsolescence due to changing conditions. The factors ordinarily involved in the calculation will be:

1—Interest on investment.
2—Depreciation.
3—Administrative cost.
4—Ordinary maintenance cost.
5.—Allowance for extensions, betterments, renewals.

The necessary starting point of the analysis is determination of the present value of the system. This is, of course, complicated and difficult, for the state highway systems have been developed piecemeal over a considerable period of time. Perhaps the best method would be to compute the present value by summing up the values determined for individual road sections as described by the Transportation Economics Committee of the Highway Research Board.[1]

For general study, estimates arrived at more simply may suffice. For instance, the cost of reproduction at present prices could be estimated, or the total amounts spent for construction to date, less an allowance for depreciation could be used. A method consistent with those in vogue for the valuation of other public utilities should be devised for this particular case.

Having ascertained the value of the investment the next step will be to estimate how much this will depreciate during the allotted time. An important project that should be undertaken at once is the collection of mortality records for all parts of highways, so that the modern methods used by valuation engineers in allowing for depreciation can be used. Pending the collection of such data, estimates will have to suffice. A convenient method of distributing the depreciation equally over the years will be to think of its cost as being initially financed by the sale of serial bonds which must be retired yearly with accrued interest during the allotted time. In such a case the sum required to amortize the amount of the bonds at the given rate of interest will be the usual cost of depreciation, plus interest on that part of the investment represented by depreciation. The interest on the rest of the investment or salvage value of the system must be computed at a uniform rate throughout the years.

The annual cost on the foregoing basis for a definite period of years will consist of the sum of: (1) Interest on the estimated salvage value; (2) Administrative costs; (3) Maintenance costs; (4) The annual sum of money needed to amortize the amount of the total depreciation for the period in question.

Earnings.—"Earnings" as used in this paper are charges against vehicle users for the use of the service; they are collected through taxes. Before going further it may be well to distinguish between this definition and another sense in which the term has been used. It has been said, when by reason of a road improvement the cost of vehicles operating over it has been decreased, that the reduction in operating cost has been earned by the improvement. This is, in a sense true, and it is an important factor in the evaluation of highway systems and proposed highway improvements; however, its discussion is outside of the scope of this paper.

The principle has become quite generally accepted that: *The costs of general use highways should be borne by the vehicles that use them.* This eliminates as earnings, taxes levied against adjacent real estate. If such taxes are levied and devoted to road use, they may perhaps be best thought of along with Federal Aid as sources of capital, rather than as earnings.

The charges against motor vehicle users for highway service are collected through motor vehicle license fees, taxes upon fuel and in some cases property taxes upon the vehicles.

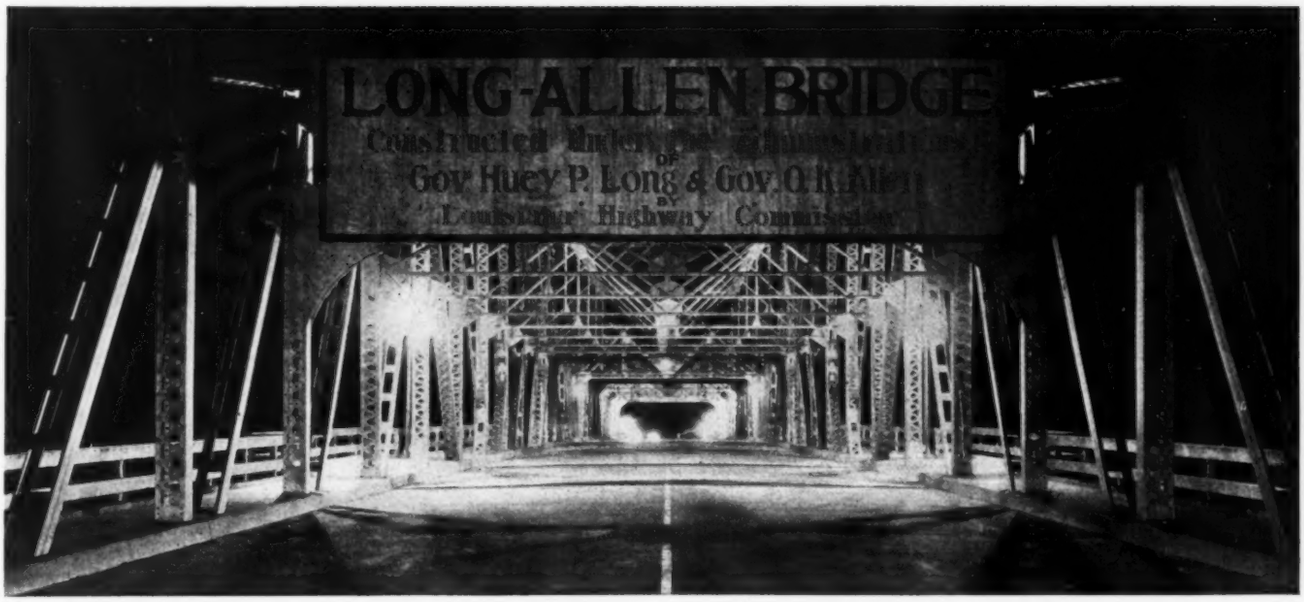
It is proper that the users should pay amounts based upon two factors, "readiness to serve" and extent of use.

Readiness to Serve. The motor vehicle license fee may be considered as a charge for readiness to furnish highway service that all vehicles using the public highways should pay. In those cases where the proceeds of general property taxes upon motor vehicles are devoted to road use, such taxes may be considered to be in this category. Where not used for road work, they have no relation to highway earnings.

Just how large readiness to serve fees or taxes should be or what part of them should be credited to the state road system or other systems is a matter for the more or less arbitrary determination of the authorities in charge, although no doubt a careful study of such analyses as we proposed would help greatly in making equitable assessments.

One consideration to take into account is the fact that in any state having large urban districts there are many vehicles, delivery cars, taxicabs and so forth, that never operate upon the rural state highway system and hence

[1]Proceedings of Highway Research Board, Vol. 9, page 369.
Proceedings of Highway Research Board, Vol. 10, page 28.
[1]Proceedings of Highway Research Board, Vol. 9, page 369.
Proceedings of Highway Research Board, Vol. 10, page 28.



Night View of a 40 x 11 Ft. Reflectorized Sign, Erected for the Dedication of Long-Allen Bridge Over the Red River at Shreveport, La.

that part of the total readiness to serve charges collected from these vehicles is not earned by the state road system, but by the city streets. It should be possible in the course of the traffic survey to ascertain this amount. With this exception, any part or all of the amount being collected in an individual state might be credited to the state highway system. For the purpose of striking a balance sheet for the system as a going concern the practical procedure may be to credit to the system whatever part of the amount collected is actually allocated to the system under existing statutes.

Metered Charge—Gasoline Taxes.—The taxes levied upon fuel by the various states are based upon the theory that through them each motor vehicle will be required to pay in proportion to its use of the roads. The ready acceptance of this form of taxation by the public demonstrates its soundness. However, this applies only when the proceeds are devoted to use on roads and streets. The excise tax on gasoline levied by the Federal Government at the present time has no relation to highway economics.

Since the gas tax is applied indiscriminately without reference to where it is used, it is obvious that not all of the money collected is derived from travel on the state road system. The amount of the tax generated by travel on the state system, can, however, be determined if the amount of traffic on that system as compared with the total traffic in the state is known.

The principle is here set up that a given system of roads should be credited as earning the tax on the gasoline used in propelling vehicles on those roads. This means that earnings from gas taxes as used herein consists of the tax collected from the fuel consumed by vehicles driving on these particular roads, and not the amount being credited to the system by the existing laws. This principle would provide a basis for the division of gas tax returns among the general use highways, land service roads and municipal streets according to the proportionate amount of traffic carried by each.

The fact that in a given jurisdiction it may be expedient to make a different distribution of the money collected in order to finance capital expenditures does not change the fact that the amounts *earned* by the roads are proportionate to their use, and it is earnings that we wish to compare with costs.

An adequate traffic survey is necessary for the determination of highway earnings. No public utility can be analyzed without knowledge of the extent to which its services are used.

Only a few states have made thorough traffic surveys. It is obvious, though, that an approach cannot be made toward the evaluation of any highway system until the amount of traffic is known.

Illustrations.—No entirely comprehensive job along the lines contemplated in this paper has been done as yet, although there have been several studies that can be cited to illustrate the type of results to be expected.

Michigan.[2 3] In an address delivered before the Nineteenth Annual University of Michigan Highway Conference, February, 1933, Professor John S. Worley gave a very thorough analysis of "Automotive Vehicle Fees and Taxes in Michigan."

Based upon actual expenditures for the years 1918 to 1931 inclusive, he calculated the sum of the annual costs for those years, of the State Trunk Highway System, including the items of interest, depreciation, maintenance and administration to be $144,561,962. For the year 1931 it was $20,334,241.

From data in Professor Worley's paper[2] and the report of the Bureau of Public Roads on the Michigan Traffic Survey[3] it was computed that the state road system carried 33 per cent of the total rural and urban traffic, and hence earned 33 per cent of the total net returns from the gasoline tax; $37,534,821 for the 1918-1931 period, or $7,076,007 for the year 1931.

The readiness to serve charges (weight taxes in Michigan) for the same periods, less necessary deductions amounted to $178,365,909 and $20,784,606 respectively. As stated before, just what readiness to serve charge should be made on behalf of the state system is a matter for more or less arbitrary decision so long as it is reasonable. One reasonable way to decide in this case would be to apportion it among the various classes of rural roads, on the basis of relative traffic. The traffic on the state highways is found to be 65.7 per cent of that on

all rural highways. The total earnings of the state system is then computed as follows:

	1918-1931	1931
Total readiness to serve charge	$178,365,909	$20,784,606
Credit 65.7 per cent for state system	117,186,412	13,655,486
Add 33 per cent of total gas tax	37,534,821	7,076,007
Total earnings of state system	$154,721,233	$20,731,493
Annual cost of state system	$144,561,962	$20,334,241

Comparing costs with earnings as computed on the bases indicated, it appears that the Michigan State Highway System has more than made expenses for the 14 years from 1918 to 1931. No deduction was made from the weight tax to cover the contributions to that fund by vehicles used exclusively on city streets for lack of data on that point. It is likely that the excess of earnings over cost shown in the analysis would cover that factor. This example is not offered as a thorough analysis as data for thorough study of the income side were not available, but it does serve to illustrate the application of the method to a case where the value of the investment is taken as original cost less depreciation.

Mississippi. Some estimates of needed expenditures on the state highway system and probable available income contained in a report on the state government of Mississippi by the Brookings Institution[5] were used in a series of articles in the Engineering News-Record[4] to illustrate the process of comparing the annual cost of improving a state highway system with its probable earning power.

It was estimated that after a seven years construction period, the total investment to be accounted for in future financing would amount to $112,000,000. The annual cost of the system making proper allowances for administration, maintenance, depreciation and interest costs was computed by the Highway Research Board formula[1] to be $8,264,000.

The probable earnings of the system after improvement were estimated to consist of:

License fees per year	$3,021,000
Gasoline tax per year	5,527,000
	$8,548,000

In this case, there being no large cities in the state, all of the license fees were credited to the state highway system and 70 per cent of the gasoline tax.

It would appear from these figures that the system would be self-supporting on the basis of existing tax rates, to say nothing of the benefits that would accrue to vehicle operators in decreased vehicle operating costs by reason of the improved surface.

Highway Research Board.—In the Tenth and Twelfth Proceedings of the Highway Research Board[1] are given the calculations of the annual costs of four individual sections of highways in three different states. These were shown with their respective earnings from license fees and gasoline taxes in the previously mentioned Engineering News-Record articles as follows in Table II.

TABLE II—COMPARISON OF ANNUAL HIGHWAY COSTS ON FOUR ROADS WITH ANNUAL EARNINGS AT THE EXISTING TAX RATES

State	Length Miles	Traffic Vehicles Per Year Passenger Cars	Trucks	Annual Costs Per Mile	Annual Earned Revenue Per Mile
Connecticut	6.55	6,075,000	675,000	$9,445	$19,703
Iowa	26.30	1,000,000	slight	2,620	3,000
Massachusetts	7.28	338,000	32,000	2,327	1,288
Massachusetts	2.94	500,000	48,000	2,685	1,920

These showings emphasize the importance of traffic density in making studies of this kind, and they also demonstrate that analyses of individual road sections cannot be used in a broad way for rate making purposes or to show economic justification for highway development. In these respects it is road systems that are significant. Quite possibly the road system of which the two Massachusetts roads are a part is self-supporting and these two roads may be justified by their function as feeders for heavy traffic routes that might show a large profit as is the case with the section of the Boston Post Road in Connecticut shown in the table.

The principal value of such studies as these on individual roads is for use in planning improvements.

Conclusion.—A specific answer to the original question "What can one do about it?" is in three parts:

1—Make a traffic survey and arrange it on a continuing basis.

2—Compute the annual cost of state highway or other system, particularly the improved part.

3—Compute the earnings of that system.

When these things are done the basic relation between the cost of the utility and its earnings will have been determined. This will show from a bookkeeping standpoint whether the system is being operated at a profit or a loss, and when we have gotten this far we can at least say. . . . If the earnings of the improved highways at equitable rates are equal to or exceed the annual cost of providing the roads, then the system is in a sound position financially, and further development and extension are justifiable.

If all of the states would proceed to analyze their state highway systems to this extent, some very pertinent and sound facts could be laid before the law making bodies, and it is difficult to see how adequate planning for the future can be done until this information if available.

The first thing that is needed is to arrange for a cost and earning study to be made in some state that already has the necessary traffic data. It is only through the carrying through of an actual analysis that details of procedure can be worked out and recommended practice prepared. The Highway Research Board hopes to have an opportunity to cooperate with some state highway department in such a project.

Acknowledgment.—The foregoing is a paper presented at the 1934 convention of the American Road Builders' Association.

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1. Proceedings of the Highway Research Board, Reports of Committee on Highway Transportation Economics, Volume 9, page 360; Vol. 10, page 329; Vol. 12, page 28.

2. "Automotive Vehicle Fees and Taxes in Michigan" by Professor John S. Worley, Michigan Roads and Airports, Vol. XXX, No. 10, March 9, 1933.

3. "Michigan Traffic Survey," *Public Roads*, Vol. 13, No. 12, February, 1933.

4. "How the Highway Pays" by R. W. Crum, *Engineering-News-Record*, June 29, July 6, July 13, 1933.

5. Report on State Highway Administration in Mississippi, Institute for Government Research of the Brookings Institution.

Progress on Public Works Highways to Jan. 27, 1934

Progress made on emergency construction of public works highways to Jan. 27 under the supervision of the U. S. Bureau of Public Roads shows a total of 5,723 projects, estimated to cost $295,205,000 had been advertised for contract or begun by day labor employed directly by the highway authorities. The cost of the day labor projects included in the above is estimated at $20,999,000.

Of the 5,001 projects awarded for construction, 3,277 were under construction on January 27, and 586 were completed. The work under construction, which is estimated to cost $189,535,000 was giving regular employment to 135,005 men.

The Origin and Composition of Sedimentary Rocks

By D. G. RUNNER

Assistant Materials Engineer, United States Bureau of Public Roads

IN a previous article,[1] the writer presented a discussion of the origin and composition of metamorphic rocks. As stated in that article, it is of fundamental importance to the engineer to have a working knowledge of the more common types of rock. If the mode of occurrence, texture, composition and other properties are understood, it is believed that one will have a better understanding of the very essential part that rocks take in engineering problems.

It is the intent of this paper to present a few distinctive features of the sedimentary group of rocks, with special reference to their origin and composition. According to Clarke,[2] the earth's crust, assuming a thickness of 10 miles, is composed essentially of 95 per cent igneous and 5 per cent sedimentary rocks. The sedimentary group is further subdivided into 4.0 per cent shale; 0.75 per cent sandstones; and 0.25 per cent limestones. From these figures it is evident that the sedimentary rocks are a relatively small part of the total amount. However, sandstones, limestones and associated sedimentary rocks play a large role in the construction and development of the present day highways, and it is with these rocks that this paper is directly concerned.

Fig. 1—Bedding in a Sand-Gravel Deposit. Note the Fine Material Resting Upon the Coarse Gravel.

The destruction of the existing rocks at the earth's surface, together with the recombining and consolidation of the materials and minerals therefrom, leads to the formation of the so-called sedimentary group of rocks. Pirsson and Knopf[3] state that the sedimentary rocks consist of material which had formed pre-existent rocks, and after weathering, disintegration, etc., has been moved from its original position to another place of deposition. Then by the action of cementing material, such as cements introduced by percolating waters, and by the weight of overlying materials, these sediments were consolidated to form rock. The transporting agents were water, glacial ice, and air currents. Water, of course, being the chief and most important medium of transportation.

Streams carry the finer soluble and insoluble material in solution or suspension, and roll the larger particles along the river bottoms. Most of the soluble products of decomposition are finally carried to the sea, while the finer insoluble material such as sand and clay is either deposited in streams or finally reaches the sea. Coarser fragments are moved from their original site, depending upon the velocity of the stream. Upon this layer of coarse material will be deposited the material next in size and so on until a regular gradation from bottom to top is built up. Thus the variation in the efficiency of the transporting medium, and in the material, produces what is known as bedding or stratification. Figure 1 illustrates this characteristic of water-laid deposits. Note the coarse particles upon which rest the finer particles.

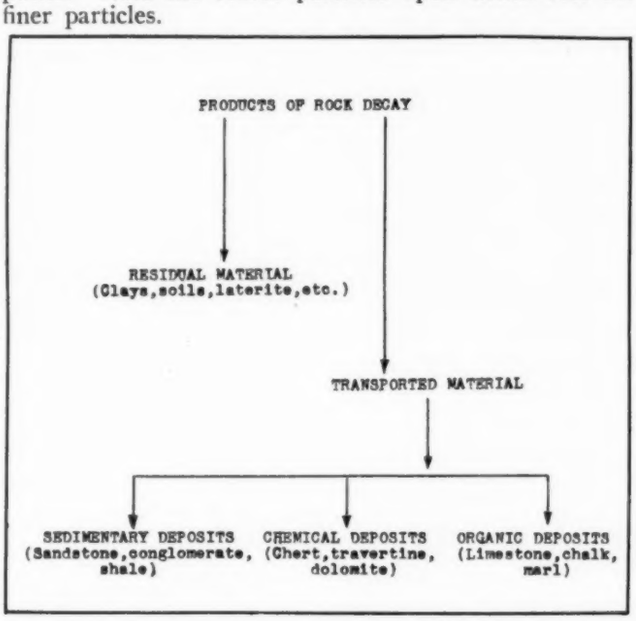

Fig. 2—Schematic Diagram of the Sedimentary Rock.

[1]The Origin and Composition of Metamorphic Rocks, ROADS AND STREETS, Vol. 76. No. 11, November, 1933.

[2]"Data of Geochemistry," F. W. Clarke, Bulletin 770, United States Geological Survey, 1924.

[3]"Rocks and Rock Minerals," Pirsson and Knopf, John Wiley and Sons, New York, 1926.

The sediments formed by water, glacial ice, and air currents as transporting agents, are designated as aqueous, glacial and aeolian respectively. Glacial deposits are usually unsorted, unstratified, and vary greatly in the kind and dimension of material. The deposits range from coarse boulders to finely divided clay and silt. The thickness of these deposits may reach 1,000 ft., but usually averages a few hundred feet. Aeolian formations are wind-blown deposits of dust, usually loosely arranged and typically intermediate in fineness between sand and clay. The name given to wind-blown deposits of this type is loess. Aqueous rocks form by far the largest and most important group, and discussion in this paper will be confined to them exclusively.

In general, the sources from which the sedimentary material is derived may be classed as follows: (1) terrestrial, (2) organic, (3) volcanic. As the volcanic sediments play a very minor part in rocks history, only the terrestrial and organic groups will be considered in this article. Terrestrial sediments, as the name implies, are those resulting from the weathering of the existent rock bodies. The disintegration and decay of rocks may be partly produced by temperature differential. Minerals have varying coefficients of expansion, and consequently tend to break up into smaller and smaller fragments. Movements of the earth's crust, as well as movements of great ice bodies also cause disintegration of the existing rock. Sediments derived from the land forms may vary according to the type of rock, the relief of the region in which the rock body is located, methods by which the rock is attacked, climatological conditions and other factors. Tyrrell[4] gives a concrete example in which is shown the products derived from the decomposition of an ordinary granite containing quartz, orthoclase, oligoclase, muscovite, biotite, zircon and apatite. The data shown below are somewhat modified from Tyrell's work but are intended to show how the minerals break down by solution, oxidation, hydration, etc., to form the chief components of sedimentary rocks shown in table above.

Mineral	Formula	Products derived from weathering
Quartz	SiO_2	Sand grains
Orthoclase	$6SiO_2$, Al_2O_3, K_2O	Clay and soluble material
Oligoclase	$20SiO_2$, $4Al_2O_3$, $3Na_2O$, CaO	Clay and soluble material
Muscovite	$6SiO_2$, $3Al_2O_3$, K_2O, $2H_2O$	Mica flakes
Biotite	$3SiO_2$, Al_2O_3, $2(Mg, Fe)O$	Clay, Soluble material and coloring matter
Zircon	ZrO_2, SiO_2	Zircon grains and crystals
Apatite	$Ca_3(PO_4)_2$, (F, Cl)	Soluble material

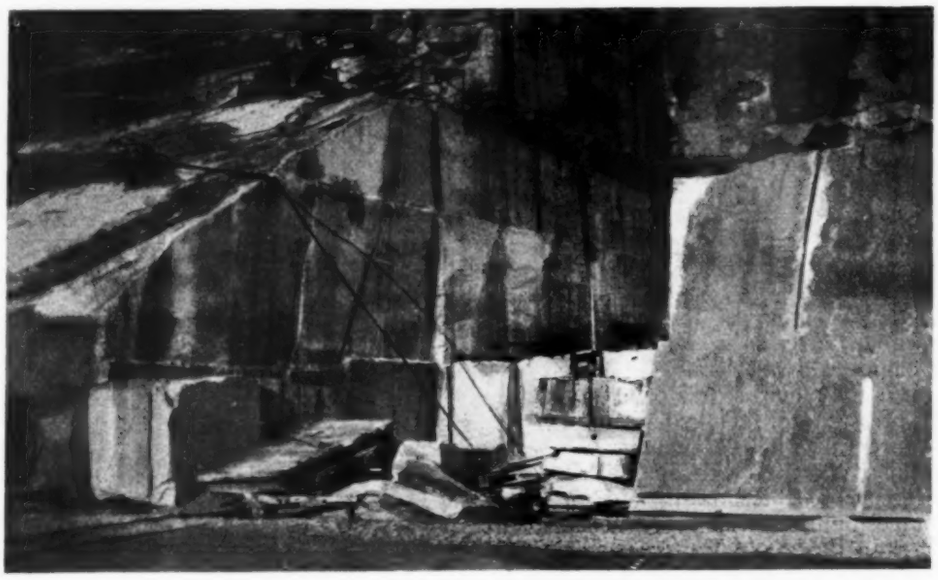

Fig. 3—Deposit of Fine-Grained Sandstone.

Fig. 4—Deposit of Limestone. Note the Bedding or Stratification Planes.

Organic sediments are those which have been precipitated through the agency of organisms, or by the supersaturation produced by evaporation. Rocks formed through the agency of any form of life, such as algae, bacteria, etc., are called organic. They are usually calcareous, siliceous, phosphatic or ferruginous in composition. Oftentimes each variety of organic matter becomes segregated and produces a sediment composed essentially of itself, but more often several varieties are intermingled.

The classification of sedimentary rocks offers no such problem as is found in the igneous and metamorphic

[4] "The Principles of Petrology," G. W. Tyrrell, p. 173, E. P. Dutton, New York.

[5] The Results of Physical Tests of Road-Building Rock, Miscellaneous Publication 76, United States Department of Agriculture, Table II, July, 1930.

Fig. 5—Map Showing Limestone Areas in the United States. (Reprinted by Permission from "Elements of Engineering Geology," by Ries and Watson.)

groups. There is nothing complicated or strange about the formation of the sediments. They are continually being formed, in the lakes, oceans and elsewhere. Millions of years hence, geologically speaking, the sediments now being deposited on river and ocean bottoms, will be consolidated to form rock. There are a few factors entering into the formation of the sedimentary group of rocks. Each product is the result of a combination of chemical, physical and/or biological conditions. The various materials transported and deposited are sorted and worked over, and it is very unlikely that a given deposit will consist entirely of a material having the same characteristics throughout. Rather, the limestones grade into sandstones, limestones into shale, conglomerates into shale, etc.

There have been numerous classifications developed for the sedimentary rock system, but it is believed that the scheme shown below will suffice for a working knowledge of the common types occurring in the United States. It should be understood that there are many varieties and kinds developed from each type shown below. However, only the "type" form, which is most likely to be of interest to the engineer, is named in the classification. It is essentially as follows:

A. Sediments derived from mechanical deposition.
   1. Sandstones
   2. Conglomerates
   3. Shales

B. Sediments derived from chemical deposition.
   1. Limestones (Coquina, marl, etc.)
   2. Dolomites
   3. Chert (Flint)

Table I illustrates these sedimentary materials before and after consolidation by pressure and cementation, and Fig. 2 offers a schematic diagram showing the origin of the sediments as well as their final consolidation as rock.

A typical sandstone is composed essentially of rounded grains, with or without interstitial cementing material, and with the larger grains tending to be more perfectly rounded than the smaller ones. Quartz, in more or less rounded grains, is by far the most abundant mineral constituent in sandstones. This is due to the fact that the chemical processes of weathering do not react upon quartz, except with extreme slowness. Singularly enough, the physical weathering does slowly break down the larger fragments, and thus gradually converts the larger pebbles into sand. Other mineral components of sandstones include feldspar, mica (usually muscovite), magnetite, zircon and other accessory minerals in lesser amounts. The cementing medium in sandstones may be either siliceous, carbonaceous, ferruginous or argillaceous. Figure 3 shows a deposit of fine grained sandstone in which the interstitial cement is chiefly siliceous.

Conglomerate is usually defined as a rock consisting of pebbles or fragments of rock held together by a calcareous, siliceous or ferruginous cement. The pebbles are generally rounded, although sometimes angular, and range in size from very large particles to the finest constituent. In general, the conglomerates consist chiefly of

TABLE I—SEDIMENTARY ROCKS, BEFORE AND AFTER CONSOLIDATION

Sediments before consolidation	Sediments consolidated as rock
Sand	Sandstone
Gravel, pebbles	Conglomerate
Silt, clay, mud	Shale
Lime deposits	Limestone
Calcareous deposits	Dolomite
Siliceous deposits	Chert (flint)

the more durable fragments which, because of their inherent toughness and hardness, have been able to withstand the rigors of transportation, and as a result have become rounded. The material which goes to make up the pebbles, of course, depends entirely upon the nature of the original rock.

Shales, although of minor importance as structural or building material, warrant a brief discussion. They are merely compacted clays or muds, having component particles too small to be defined without the use of a microscope, are readily cut with a knife, and often crumble to pieces upon exposure to air. There are numerous varieties of shale; carbonaceous, oil, limey, ferruginous, etc., depending upon the chief mineral component. Shales quite often grade into sandstones by the increase in the amount and/or size of the quartz grains.

Limestones are classed among the most extensive and important sedimentary rocks. They are composed essentially of calcium carbonate, which has been produced by organisms, or by direct precipitation without organisms, or by the accumulation of fragments of older limestones. Limestones are moderately to extremely fine grained, porous to dense, and break with a fairly uniform fracture. Gray limestones, which are due to organic matter, are most common, although white, yellowish, brown and even black varieties are known. The purest limestones, of course, are white. The yellow and brown varieties are due chiefly to the high content of iron oxide. There are also many varieties of limestone which are due to the manner of their formation. Coquina is one type containing a large amount of shells and organic remains imbedded in or forming a large part of the rock itself. This type of rock is quite common in Florida. Marl, another variety of limestone is composed chiefly of calcium carbonate together with a variable proportion of impurities. Deposits of marl are quite often found in lakes, especially where the shores are offered protection by vegetation against the invasion of mud or sand. Those limestone containing a high percentage of clay, are called argillaceous, likewise those containing high percentage of silica and organic matter are called arenaceous and carbonaceous respectively. Due to the fineness of the limestones, the bedding or stratification is very often a distinguishing characteristic. Figure 4 shows a limestone quarry in which this feature is quite marked. Figure 5 illustrates the principal areas in the United States in which limestones are found.

Dolomite, although the name of a mineral, is used to designate the type of rock theoretically containing 54.3 per cent calcium carbonate and 45.7 per cent magnesium carbonate. Actually these percentages vary greatly. It is believed that the dolomite has been formed by alteration of the original calcium carbonate in limestones, to calcium-magnesium carbonate by means of interaction with oceanic waters in which the deposit was laid down.

TABLE II—CHEMICAL ANALYSES OF THE SEDIMENTARY ROCKS

	Sandstone	Shale	Limestone	Dolomite	Chert
SiO_2	84.86	60.15	5.19	3.24	98.17
Al_2O_3	5.96	16.45	0.81	0.17	
Fe_2O_3	1.39	4.04	....	0.17	
					0.83
			0.54		
FeO	0.84	2.90		0.06	....
CaO	1.05	1.41	42.62	29.58	0.05
MgO	0.52	2.32	7.90	20 84	0.01
H_2O	1.74	4.71	0 77	0.30	0.78
CO_2	1.01	1.46	41.58	45.54	....

Data selected from "Data of Geochemistry," by F. W. Clarke, Bulletin 770, U. S. G. S., 1924.

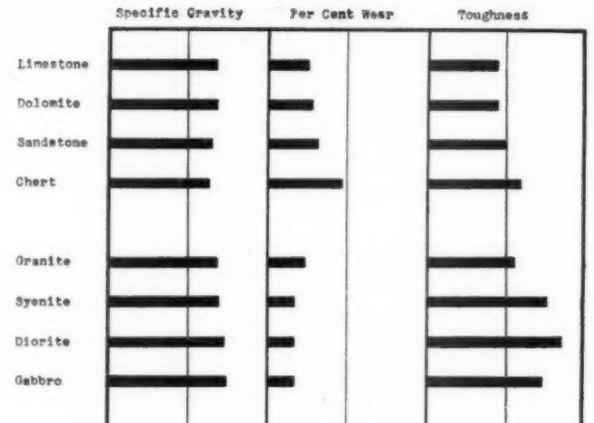

Fig. 6—Average Physical Test Results.

The change is probably one of replacement, of the calcium by the magnesium atoms. Dolomites are similar in color and texture to limestones, with the exception that they are inclined to be more porous. In addition, the dolomite as a rule is harder than limestone.

Chert (flint) is a fine grained dense rock, composed essentially of crystalline silica, together with some accessory minerals such as iron oxide, organic matter or other mineral matter. Chert is usually found in beds, lenses, or as concretionary masses in limestone formations. It is thought that these chert forms represent silica precipitates on the ocean floor, while others say that silica has been deposited around the hard skeletons of sponge spicules or other organic remains. Chert has a fairly homogeneous texture, usually gray, black or whitish in color, and breaks with a conchoidal fracture.

In order to show the great variation in the chemical analyses of the various types of sedimentary rocks, Table II is given. These data were selected from "Data of Geochemistry," by F. W. Clarke, and are the results of a large number of analyses of the rock types indicated. Only the chief mineral components are given in this table.

Figure 6 shows the average physical properties of the sedimentary, igneous and metamorphic rocks, as determined in the laboratory of the United States Bureau of Public Roads.[5] The values indicated may not be true for all samples of the rock type shown, but may be considered as average. Reference to Figure 6 indicates that the sedimentary rocks on the average offer less resistance to toughness than either of the igneous or metamorphic rocks. Likewise the percentage of wear is higher in the case of the sedimentary group. In general the density of the metamorphic types is greater than the other two groups.

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Summary of Federal Highway Progress Under $400,000,000 Allotment

By THOS. H. MACDONALD

Chief, U. S. Bureau of Public Roads

DURING the period that the providing of jobs for the unemployed has been the big national problem, there has been a constant flow of suggestions to Washington that the best way—that the only sure way—to supply these needed jobs, is for the Federal Government to undertake the building of a great highway from coast to coast. Sometimes these suggestions are made definite by the mention of the route or the particular city through which such a highway should pass. Sometimes there are other details as to the design, materials or methods of organization. Frequently there are offers to undertake the management of such an enterprise.

While a good many of the varied suggestions of this type are plainly inspired by some motive not altogether unselfish, perhaps the majority are sincere and predicated upon the honest belief that by undertaking such a program the Federal Government would actually be able to take up all surplus labor. Of course this does not represent the viewpoint of those who have undertaken to give serious consideration to the dimensions of the problem of unemployment, or rather the dimensions of the cumulative series of unemployment problems with which the country has been confronted. Neither does it indicate any adequate comprehension of the scale upon which the Administration has been attacking the problem of unemployment and the other problems arising out of, or rendered acute by, the depression.

What Is Being Done Under the $400,000,000 *Allotment.*—There is no possibility of indicating the scale of any one of the major attacks now being carried forward by the Federal Administration through statistics. Information of this type is widely available constantly, but it does not produce a real comprehension. Perhaps it might be possible to illustrate something of the scale of the single operation of road building undertaken through the Bureau of Public Roads and the State highway department with the allotment of $400,000,000 which became available early in July after the passage of the National Industrial Recovery Act.

A transcontinental highway extending from the Atlantic to the Pacific Coast would be in the neighborhood of 3,000 miles long. The exact length would depend somewhat upon the particular line chosen. During a period of less than six months, from July to January, under the Federal Public Works appropriation, construction has been actually undertaken of a road mileage sufficient to build six transcontinental lines. For those who desire a wide highway from coast to coast, if these six lines were brought together into one great highway, construction would now be under way to provide a surfacing upwards of 110 ft. wide on a road bed about 200 ft. wide, over a right of way 400 ft. wide.

Such an example may help to give some conception of the scale of the construction work on highways which has been actually undertaken in less than six months. Again consideration has been given to the building of roads from the United States of North American through Mexico and Central America into South America to reach the capitals of all the countries and to tie the whole Western Hemisphere together by overland routes.

The average reaction to such an undertaking is that while it might be desirable, it is impossible and impracticable. As a matter of fact it is only about 3,000 miles from the United States border at Laredo, Texas, to the Panama Canal, or a distance approximating the distance across our own country from east to west.

The highway work which has been undertaken for the major purpose of relieving unemployment in the past six months, without taking into account the incidental road and trail work done by the CCC camps, or the highway work that will be accomplished through the CWA program, but only the program administered through the Bureau and the State highway departments, would be equal to six highways from the United States border to the Panama Canal. This mileage would extend a road from the United States through Mexico, Central America and connect all the capitals of South America. Assuming that the remainder of the program continues in about the same proportion, this single program will produce a mileage equal to a highway around the world, although I do not assert there will be sufficient bridges included to span the oceans.

The Work Widely Distributed.—Actually, this work has not been concentrated upon any single line or class of highways, but has been distributed widely to reach into nearly every county of every State. There are included mileages of both secondary or farm roads as well as municipal streets which are a part of important highway routes, thus distributing work where work is needed to reduce unemployment which would not be easily accomplished by single line construction.

A summary of the work now under way as of Jan. 1st is shown in Table I.

Municipal Projects Lag.—The above summary covers about two-thirds of the program. The projects on the Federal-aid highway system and on secondary roads, however, are advanced in a greater percentage than the municipal projects. This lag in municipal projects is characteristic and was to be expected since the undertaking of work within the cities projected the highway departments into a field which they had not heretofore occupied and for which there were no preparations.

The same lack of plans existed for secondary roads but more of the highway departments were engaged in some measure in this field and the type of work generally undertaken was of the lower cost type similar to that on which they were already engaged.

The municipal program, however, on Jan. 1st was more than 50 per cent under way and these projects are being rapidly matured now. The entire program should reach 22,000 to 23,000 miles, roughly divided in the same proportion as to types as the approximately 18,000 miles included in the schedule of work already under way.

This side of the picture has been presented first to emphasize that which will remain when the $400,000,000 shall have been expended. These miles of newly constructed highways are not the reason for, but the results of a policy inaugurated to provide opportunities for employment. The extent to which this purpose is being and will be accomplished is indicated by our estimate

TABLE I—U. S. PUBLIC WORKS HIGHWAY PROJECTS BY TYPES OF CONSTRUCTION AS FOR DEC. 31, 1933

Types	—NRH Projects— Estimated total cost	Miles	—NRM Projects— Estimated total cost	Miles	—NRS Projects— Estimated total cost	Miles	——Total—— Estimated total cost	Miles
Graded and Drained	$19,838,939	2,408.0	$2,046,594	92.9	$10,284,007	1,648.1	$32,169,540	4,149.0
Sand Clay—								
Untreated	853,926	228.6	79,996	12.1	1,774,452	329.2	2,708,374	569.9
Treated	2,388,851	314.7	138,980	16.6	1,676,916	226.4	4,204,747	557.7
Gravel—								
Untreated	17,025,178	2,185.6	630,927	66.9	14,990,160	2,721.0	32,646,265	4,973.5
Treated	4,027,759	431.8	609,616	39.6	7,400,845	846.3	12,038,220	1,317.7
Macadam—								
Untreated	1,677,416	103.3	146,409	7.0	488,541	93.5	2,312,366	203.8
Treated	2,015,140	122.4	357,442	11.4	1,504,827	104.7	3,877,409	238.5
Low Cost Bituminous Mix	12,346,259	1,461.7	733,257	48.0	2,838,124	291.4	15,917,640	1,801.1
Bituminous Macadam	5,930,043	249.5	1,613,929	33.1	2,704,465	178.5	10,248,437	461.1
Bituminous Concrete	9,076,174	363.0	10,834,456	167.1	2,895,746	175.9	22,806,376	706.0
Portland Cement Concrete	59,176,502	1,865.6	24,132,858	430.0	8,108,774	225.3	91,418,134	2,520.9
Block	1,704,414	30.0	2,453,070	28.0	351,050	5.0	4,508,534	63.0
Bridges and Approaches	18,617,074	50.8 (1,601)	6,831,849	7.5 (199)	6,812,839	13.9 (631)	32,261,762	72.2 (2,431)
Grade Separations—Railroad, Highway	2,892,474	7.1 (82)	2,239,437	3.0 (45)	679,166	2.0 (23)	5,811,077	12.1 (150)
Grade Separations Between Highways	68,450	.2 (2)	635,443	.3 (7)	.....	.....	703,893	.5 (9)
Miscellaneous	107,892	....	48,674	...	59,844	.....	216,410	.....
Total	$157,746,491	9,822.3	$53,532,937	963.5	$62,569,756	6,861.2	$273,849,184	17,647.0

Note.—The figures in parentheses indicate the number of structures.

that this highway program will provide a cumulative total employment in direct labor on the jobs of 2,500,000 man months.

Beginning with August the daily average employment directly on the work was gradually stepped up until it reached for November, 132,000 men. This figure is for continuous employment and must not be confused with the number of individuals given work. Our records so far show a ratio of 1.8 individuals included on the pay rolls for each one reported continuously employed. That is, the work to provide continuous job employment for 132,000 men, represented in November employment for longer or shorter periods of 236,000 individuals directly on the work. Nor does this take into account the auxiliary industrial employment.

For November our estimates for direct and industrial employment indicate that the highway program was carrying a total of 330,000. The total was held to approximately the same figure for December and to date there is no indication of a falling off during January and February. There will unquestionably be a rapidly increasing rate of employment through March, April and May, to a peak in June and July of about 280,000 average daily continuous employment. Nearly one-half million individuals will go on the pay rolls to fill this number of jobs continuously. This employment will hold through July and part of August and will then fall rapidly until the first of the year when the work will have been practically completed.

The completion of this program as Federal appropriations now stand will end the Federal coöperative highway work with the State highway departments unless there is additional Federal legislation meantime to provide for its continuance.

New Principle Incorporated.—The present Public Works highway program, while being carried on generally in accordance with the existing Federal-aid highway legislation, has been modified by incorporating a number of important new principles. A decided stimulus has been given the elimination of dangerous grade crossings through the underwriting of the entire cost from the public funds and relieving the railroads of contributions which have been heretofore required generally under State laws.

The law itself emphatically declared for greater progress in the elimination of highway hazards by making it possible to include the entire cost as a charge against the public funds. In keeping with the spirit of the Act, the Secretary, through the Special Board for Public Works, announced the principle that approval would not be given to projects which would require involuntary contributions on the part of the railroads. Considering the financial plight of many of the railroads where improvements were most seriously needed, any other course would have led to the incongruous situation of the Government taking steps to aid the railroads financially on one hand, while on the other making it possible for the States, through the operation of State laws, to make assessments in some States running into considerable totals upon the railroads for such improvements.

As a commentary upon this particular subject, many State laws now in effect are the product of a time long past when relative traffic conditions on the railroads and the highways had no relation to those of the present. While improved economic conditions will be reflected in rail earnings, this will not do away with the desirability of a thorough revamping of a large number of the State laws with reference to the division of costs for grade crossing improvements.

A second policy which we believe important has been the elimination of the purchasing of materials, notably cement, by the States. There was a time, when this policy first came into use, when a number of advantages accrued to the States, but these advantages had long since disappeared and very serious disadvantages and dishonest practices were creeping into the situation. The public has a right to a clean administration of the public funds, and insofar as it lies within the power of the Bureau of Public Roads, every policy which results in manipulation or attempted manipulation of contracts will be discarded.

The previous principle of the Federal highway legislation to hold the Federal appropriations on a limited system of highways was modified by the new Public Works law to permit the improvement of the major routes into and through the municipalities. While this slowed down the immediate beginning of the work, because of projecting the highway departments into an almost entirely new field, it does place the construction work in the vicinity

When Oscar L. Chapman, Assistant Secretary of the Interior and executive secretary of the special board of public works, arrived Jan. 23 at Chicago on the Capitol Limited from Washington to address the annual banquet of the American Road Builders Association, he was greeted at the station by a committee representing the association. In the welcoming committee were Capt. H. C. Whitehurst, Washington, D. C., president of the association; J. H. MacDonald, New Haven, Conn., treasurer and past president; C. M. Upham, Washington, D. C., secretary; H. G. Sours, Akron, O.; C. H. Grubb, Washington, D. C.; Robert B. Brooks, St. Louis, Mo.; B. F. Affleck, president of the Universal Atlas Cement Company; A. C. Cronkrite and M. A. Berns of Chicago. Joining the committee in welcoming Mr. Chapman were his nephew, Dr. Wendell Lund, professor of English at Augustana College, Rock Island, Illinois, and a friend, Stanley E. Nelson. Shown in the illustration are, front row, left to right: H. G. Sours, R. B. Brooks, J. H. MacDonald, O. L. Chapman, Capt. H. C. Whitehurst, C. M. Upham, and C. H. Grubb. Rear row: M. A. Berns, A. C. Cronkrite, Stanley Nelson, Dr. Lund, and B. F. Affleck.

of greatest need for employment, and has the advantage of not dislocating labor from its established environment. This work is also directed toward the improvement of unquestionably one of the worst conditions affecting traffic that now exists, and the Bureau is very much in sympathy with the work in the municipalities, although it has increased the difficulties of administration both for the State highway departments and for the Bureau.

Out of this program, however, will come some notable improvements in traffic conditions all over the country, and when the depression shall have passed there will remain tangible benefits more than justifying the expenditures. Also, the use of Federal funds for the improvement of secondary roads has brought opportunities for employment most seriously needed and is leaving behind facilities amply justifying the expenditures.

Another principle that has been emphasized is that of more adequate rights of way and intelligent and extensive landscaping consistent with the purposes of the utility which is being provided. Roadside improvement has been too long neglected. While there may be those who are reluctant to undertake any considerable amount of this work until we shall have more adequately improved the roadways themselves, an analysis of the necessary cost of more beautiful highways will not support a longer deferment of this type of work. The Bureau is not only in sympathy with this character of improvement but is a very insistent exponent.

It has long been recognized that the social and recreational use of the highways accounts for a large part of the traffic upon them. Complete analysis of the taxes and imposts indicates that highway users are paying heavily for their privileges. The total income from all kinds of taxes paid in 1932 by highway users approximated $1,000,000,000.

As a matter of simple fairness the highway user should not be denied appropriate roadside improvements generally. The selfish interest of the road builder who desires to increase the highway earnings, should prompt him to provide attractive highways that will lead to their greater use. In the future it will not be sufficient for States to supply good roadways. They will necessarily have to meet the competition of States that are providing beautiful highways.

Acknowledgement.—The foregoing is a paper presented Jan. 22 at the annual convention of the American Road Builders Association.

Workers Set Fast Pace on Public Works Highway

What the U. S. Bureau of Public Roads believes to be a speed record in road building was established recently in the building of a Public Works highway in the San Juan National Forest in Colorado. The road, known as the Pagosa-Chama forest highway, is part of the main-traveled route between Sante Fe, N. Mex., and the Mesa Verde National Park. Only 49 days of the 200 allowed to complete this 4½-mile section of road were required to put the highway in service, according to the report of the bureau, which was in charge of the construction.

Work accomplished on the section of road built so rapidly included, grading to a 24-ft. width, building two major drainage structures of concrete, and placing two 4-in. layers of crushed surfacing material.

"This project," the report states, "proved a veritable godsend to the community, which depends on grazing, farming and lumbering for its living. Of the 276 men registered for employment in the county, 211 were given employment on the road work. This represented 6,400 men-days and 2,300 stock-days of work.

Early Strength Concrete—
Effect of Temperature

By H. F. CLEMMER

Engineer of Materials, District of Columbia, Washington, D. C.

THE necessity of putting and keeping men at work during this present economic crisis has caused those in charge of construction to give particular thought and attention to "All Year Construction," rather than construction for seven or possibly eight months of a year.

The old practice of discontinuing ordinary construc-

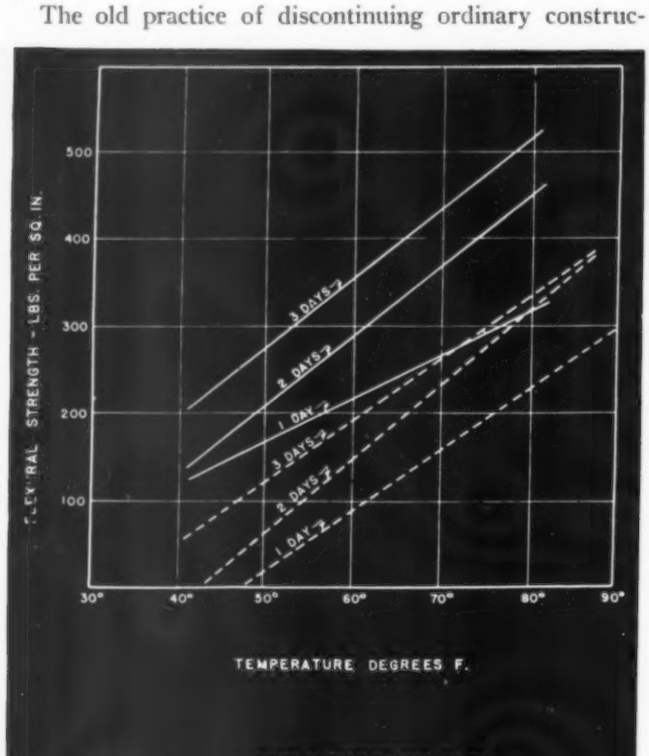


Fig. 1

tion, involving the placing of concrete, as soon as cold weather set in, not only left costly equipment idle and non-producing, but left men unemployed and made yearly construction costs excessive.

In the northern part of our country, where winter brings heavy snows and very low temperatures, highway construction is difficult and uneconomical, but in localities where temperatures very seldom reach zero, and generally do not go lower than 10 or 15 degrees, concrete highway work can proceed with assurance of satisfactory results if judgment is used in the methods of construction and of handling materials.

Engineers realize that the quality of concrete, particularly the strength factor, is adversely affected by temperatures near freezing, but seldom give any consideration to the effects of temperatures between 40 and 70° F. A study of field test results will show that it is important to consider temperature conditions at the time of placing concrete, particularly when early strength concrete is desired.

This fact was first brought to the direct attention of the Highway Department of the District of Columbia when results of field tests on concrete specimens from paving projects were studied to learn the effect of various construction conditions. The relation of strength to the temperature at the time of placing the concrete, as plotted on Fig. 1, shows strikingly the effect that the temperatures had on the early strengths of the concrete.

Due to this evidence a carefully controlled laboratory investigation was conducted to determine the effects on concrete of rising and lowering temperatures such as prevail under actual constructions, and of various constant temperatures.

A report of a study made some years ago by Professor McDaniels is of particular interest in comparing strengths of specimens at 28 days (Fig. 2). These results indicate a reduction in the ultimate strength of concrete, due to the effect of lowering temperatures, which indication was substantiated by a report on the Wacker Drive Project by Dr. A. R. Lord.* The discussion to follow, however, considers only the early strength of the concrete.

In studying the investigation conducted by the Highway Department of the District of Columbia it was noted that the results of tests of concrete placed at 40°, 50° and 70° F. (the concrete being maintained at the stated temperatures during the curing period) show an approximate decrease of 65 per cent in compressive strength at two days for a 70° to 50° change in temperature and an 85 per cent decrease for a change from 70° to 40° F.

Effect of Rising or Lowering Temperatures.—A factor of particular significance is the effect of rising or lowering temperatures, immediately after the placing of the concrete, and the length of time these temperatures prevail. Tests on concrete specimens were made with a

*American Concrete Institute, 1927.

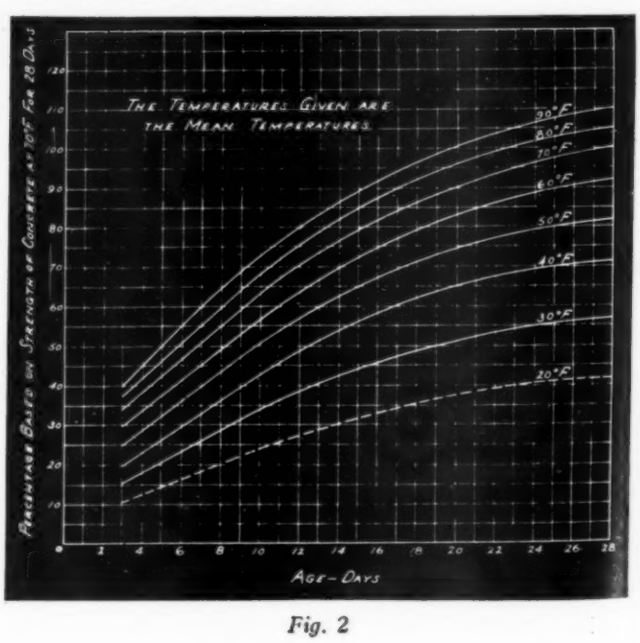


Fig. 2

series starting at 40° F. and rising to 60° F. Also, tests were made starting at 60° F. with one series rising to 70° and another series lowering to 40° F. These cycles required 24 hours for completion, 12 hours falling, or rising, to the stated temperature, and 12 hours rising, or falling, to the original temperature. Seven complete cycles were made in each case.

It will be noted (Fig. 3) that the concrete placed at 40° F. on a rising temperature to 60° F., attained greater early strength than that placed at 60° F. on a lowering temperature to 40° F. This fact is pertinent in considering recommendations for special provisions for winter

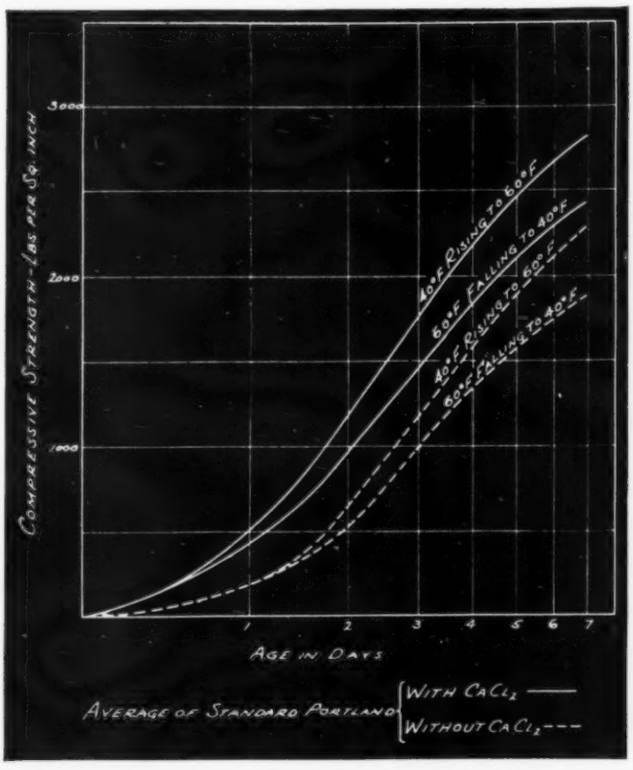


Fig. 3

concrete construction and will be referred to later in this paper.

Realizing the value of accelerating the rate of set in overcoming the effect of lower temperatures on the early strengths of concrete, calcium chloride was incorporated in the mix in order to determine the effect this accelerator would have in overcoming these adverse conditions. The results of the use of 1½ per cent of calcium chloride per sack of cement are shown on Fig. 4. These data show that:

When concrete is placed at 70° F. pavements may be opened to traffic in one day when high early strength cement plus calcium chloride is used; in two days when either high early strength cement or standard portland cement and calcium chloride is used; and in four days when standard Portland cement alone is used.

When concrete is placed at 50° F. pavements may be opened to traffic in two days when high early strength cement plus calcium chloride is used; in three days when high early strength cement is used alone; in five days when standard Portland cement and calcium chloride is used; and in approximately nine days when standard Portland cement alone is used.

When concrete is placed at 40° F. pavements may be opened to traffic in four days when high early strength cement plus calcium chloride is used; in seven days when high early strength cement or standard Portland cement and calcium chloride is used; and in approximately twelve days when standard Portland cement alone is used.

A difference in temperature of 20° F. (70 to 50) increases the minimum safe opening period one day; a difference of 30° F. (70 to 40) increases this minimum opening period three days.

The Highway Department of the District of Columbia has found that by increasing the amount of standard Portland cement and using calcium chloride that a marked increase in early strength of the concrete is produced.

A correlation of the results of field tests made during the past year under varying temperature conditions substantiates these laboratory data.

Since much of the concrete placed in highway construction has a comparatively low unit cement content, a series of tests was conducted to investigate the possibility of using various cement factors, as well as of using calcium chloride integrally, to assure the same strength at early ages for concrete placed at lower temperatures as that obtained with a specified amount of cement in concrete placed at 70° F. (Figs. 5 and 6).

The increase in early strength of concrete due to an increase in unit cement content is shown by the results of laboratory tests as plotted (Fig. 5). Concrete containing 1.6 bbl. of cement per cubic yard and cured at 70° F. attained a 24-hour strength of approximately 900 lb./sq. in. as compared to only 300 lb./sq. in. for concrete containing but 1.04 bbl. of cement per cubic yard. The use of calcium chloride increased the strength of the richer concrete to 1,300 lb./sq. in. at 24 hours as compared to 500 lb./sq. in. for the leaner concrete.

The results of field tests as plotted (Fig. 6) show that an increase in the unit cement content is an important factor in overcoming the effect of lowering temperatures, particularly at early ages.

A program of tests similar to the foregoing was also conducted, using three high early strength cements. The results indicated the same general effects of temperature on high early strength cement concrete specimens as was noted on the standard cement concrete specimens, Fig. 4.

Following a careful study of the results of these laboratory investigations, all concrete placed in the field

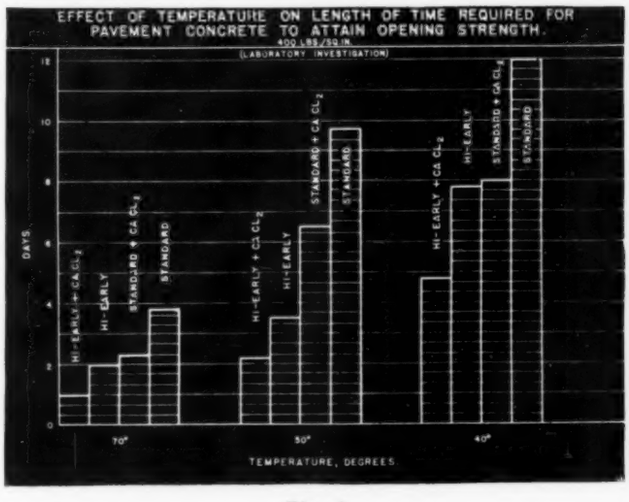


Fig. 4

thereafter was controlled in accordance with the prevailing temperature.

Control of Concrete in Pavement Construction.—The following is a report on the control of the concrete used in the construction of pavement on "F" St., NW, one

of the most important business streets in Washington, D. C.

(A) This project consisted of the construction of several blocks (10,500 sq. yd.) of sheet asphalt pavement on a 9-in. reinforced concrete base. One side of the street in each block was constructed at a time. Tearing up of the old pavement and the preparation of the sub-

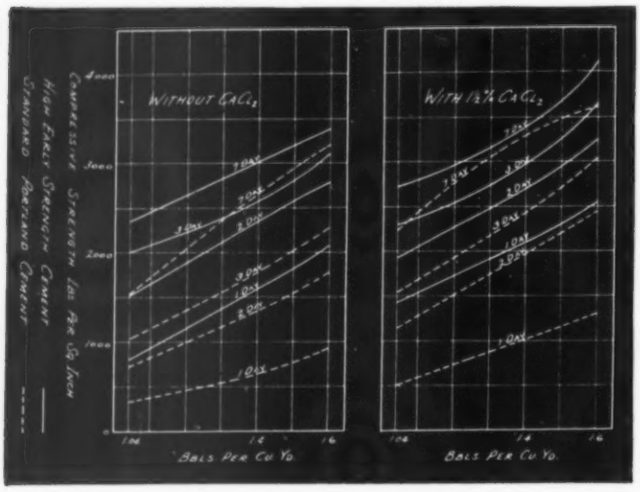


Fig. 5

grade was completed during the night so that placing of the concrete could be started in the morning.

The time required for base concrete to gain sufficient strength to permit the placing of asphaltic binder and top, generally causes considerable delay in construction. Particular effort was made to study the conditions on this project and by proper control of the concrete reduce this delay to a minimum. As a result the required strength (300 lb./sq. in. in flexure) before placing the binder and top was obtained in all instances in from 24 to 30 hours.

The specifications required that 1.04 bbl. of cement per cubic yard of concrete be used, but permitted the use of high early strength cement in lieu of standard Portland

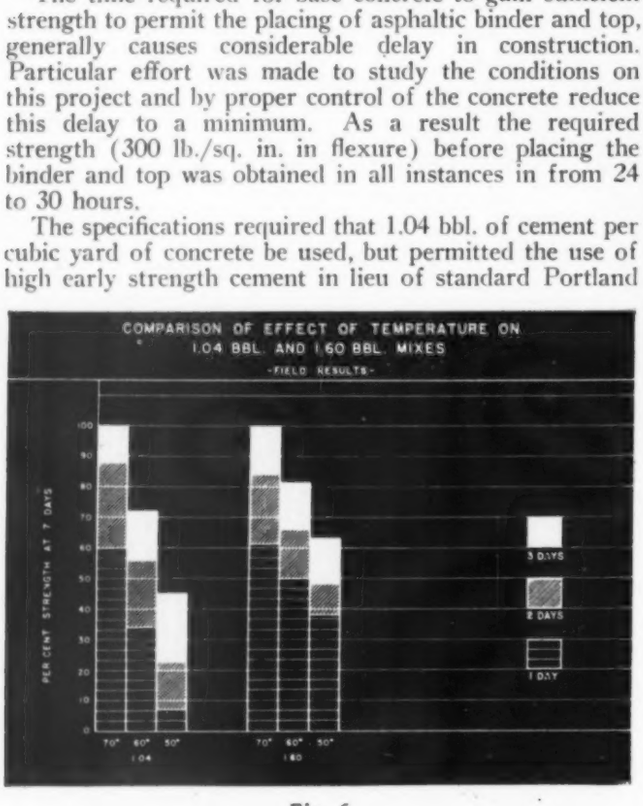


Fig. 6

cement, or of additional standard Portland cement at the direction of the engineer.

Since the unit cement content was low (the department has since increased the cement factor to 1.25 bbl. per cubic yard for base concrete) it was of interest to consider the use of additional standard portland cement to improve durability, rather than the use of the basic amount of high early strength cement.

A study of the tests reported in the previous investigation indicated that satisfactory strength of concrete would be secured by using an additional bag of cement per cubic yard plus a varying percentage of calcium chloride, according to the temperature at the time of placing the concrete. It was not necessary, therefore, that high early strength cement be used, which, under the terms of this contract, would have increased the cost over the other method. Within the temperature range encountered on this project the conclusions from the laboratory investigation recommend either the use of high early strength cement, or of additional standard cement plus calcium chloride. The latter method was followed for economic reasons.

(B) The results of field tests made of the strengths of concrete on this project, as plotted on Fig. 7, show that within the particular range of temperature encountered, the concrete with one extra bag of standard portland cement per cubic yard plus calcium chloride produced a flexural strength as high as the standard mix using high early strength cement. It also may be noted that there was but little gain in strength using high early strength cement plus 1½ per cent calcium chloride in place of one additional bag of standard portland cement plus 1½ per cent calcium chloride. This gain in strength was not sufficient to warrant the increase in cost as both mixes produce concrete of satisfactory strength; and it is be-

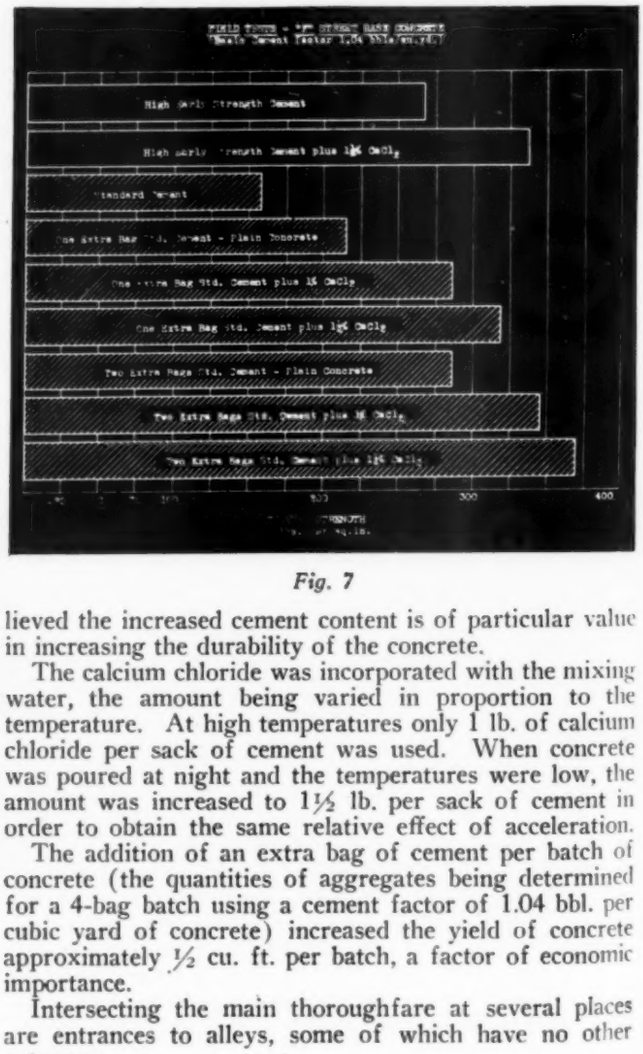


Fig. 7

lieved the increased cement content is of particular value in increasing the durability of the concrete.

The calcium chloride was incorporated with the mixing water, the amount being varied in proportion to the temperature. At high temperatures only 1 lb. of calcium chloride per sack of cement was used. When concrete was poured at night and the temperatures were low, the amount was increased to 1½ lb. per sack of cement in order to obtain the same relative effect of acceleration.

The addition of an extra bag of cement per batch of concrete (the quantities of aggregates being determined for a 4-bag batch using a cement factor of 1.04 bbl. per cubic yard of concrete) increased the yield of concrete approximately ½ cu. ft. per batch, a factor of economic importance.

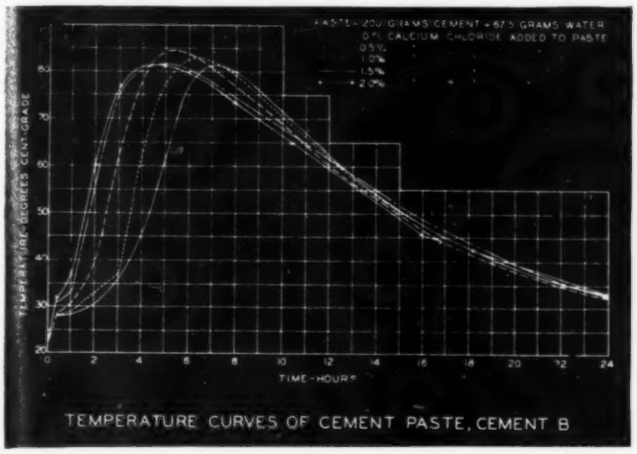
Intersecting the main thoroughfare at several places are entrances to alleys, some of which have no other entrance.

(C) It was imperative that these intersections be completed as soon as possible so that there would be no delay in servicing those business houses.

In one case the largest theatre in Washington was serviced by an alley which had its only opening on this street. The concrete base for this entrance was placed at one o'clock in the afternoon and specimens broken at 10:00 p. m. showed a strength of 280 lb./sq. in. Planks were placed on the concrete surface and the alley opened to traffic. Subsequent tests at 18 hours gave a flexural strength of 415 lb./sq. in. One additional bag of standard portland cement and calcium chloride were used.

What the Control Check Shows.—The results of this control check show:

(1) Increasing the unit cement content from 1.04 to 1.25 bbl. per cubic yard and using 1½ per cent of calcium



TEMPERATURE CURVES OF CEMENT PASTE, CEMENT B

Fig. 8

chloride by weight of the cement (a) produced as high early strength concrete as using the basic amount of high early strength cement and calcium chloride; (b) permitted a considerable saving under the prices quoted for this contract; and (c) made a more durable concrete. (Scholer—Durability of Concrete, Highway Research Board Proceedings, 1930.)

(2) It is important to place concrete on a rising temperature, in order to increase the early strength of concrete, *unless special provisions are provided for maintaining the temperature of the concrete.* During low temperatures concrete should be placed in the morning and permitted to have the afternoon when the temperature is rising to gain its initial set, rather than placed in the afternoon during the highest temperature, but which would subject it to the lowering temperatures immediately following its placing.

Following is a statement of the record of progress as furnished by the Engineer of Construction:

ENGINEER'S PROGRESS RECORD, "F" STREET

Location	Excavation Started	Completed Pavement Opened to Traffic*	Time lost due to Inclement Weather
13th to 14th, S. side..	Aug. 1	Aug. 4	
N. side..	Aug. 6	Aug. 9	
12th to 13th, S. side..	Aug. 10	Aug. 12	
N. side..	Aug. 13	Aug. 17	1 day—rain
11th to 12th, S. side..	Aug. 20	Aug. 27	3 days—rain
N. side..	Aug. 28	Aug. 30	
10th to 11th, S. side..	Sept. 5	Sept. 8	
N. side..	Sept. 10	Sept. 13	
9th to 10th, S. side..	Sept. 13	Sept. 17	1 day—rain
N. side..	Sept. 18	Sept. 21	

*Sheet asphalt on Concrete Base.

Potomac River Sand and gravel, and Capitol cement were used through the project.

Winter Construction.—Construction during temperatures near freezing requires special attention not only to assure a reasonable rate of hydration of the cement, but make certain that the moisture in the concrete will not freeze and cause permanent injury.

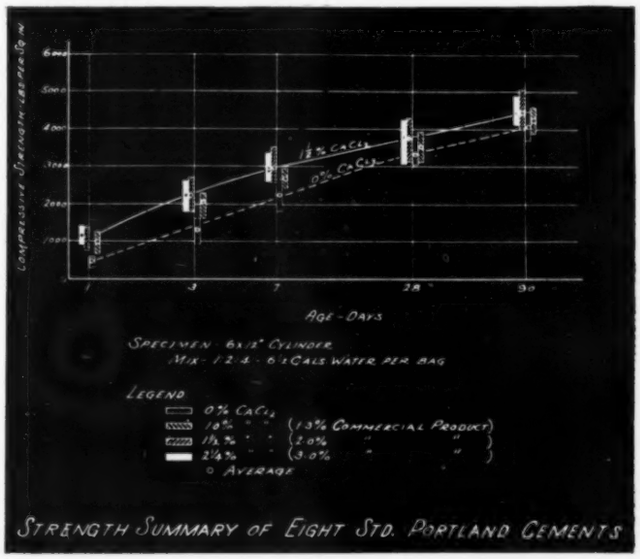
Field tests, however, have proven the practicability of providing the protection necessary for satisfactory "Winter Concrete Construction," that is, for placing concrete during low temperatures.

Realizing the importance of the temperature of concrete on the rate and degree of hydration of cement in concrete, the Highway Department of the District of Columbia requires that special precautions shall be taken whenever the temperature may reach 50° F., or below, during the 24 hours following the placing of the concrete.

Field tests definitely established the same conclusions as were indicated by the laboratory investigation, which showed the importance of placing concrete during a rising temperature, unless special provisions are made for covering so as to maintain the temperature of the concrete.

On one paving project where concrete placed on Dec. 27, when the temperature was as low as 14° F. was started at 7 a. m. Specimens were made from concrete mixed at 10 a. m. and from concrete mixed at 2 p. m. when the pouring was stopped. The average 48-hour strength of the specimens made at 10 a. m. was 415 lb./sq. in. while of those specimens made at 2 p. m., it was 286 lb./sq. in., indicating that too little time had elapsed for the concrete placed in the afternoon to gain strength before the temperature started lowering. Six bags of cement per cubic yard of concrete and calcium chloride admixture were used in the mix.

The hardening of concrete is a chemical reaction requiring heat and moisture. Any increase or decrease in the temperature causes an increase or decrease respectively in the rate of setting of the cement. Should the



STRENGTH SUMMARY OF EIGHT STD. PORTLAND CEMENTS

Fig. 9

temperature of the concrete become so low that the chemical action is entirely stopped it requires considerable time and increase in temperature to start the hydration process again.

During the summer months the important problem in curing is to maintain sufficient moisture for maximum hydration of the cement, but during the winter months the problem is to keep the temperature of the concrete sufficiently high that maximum hydration may be obtained.

It is therefore, important to speed up the setting of the cement to every practicable extent in order to reduce

the lengh of time necessary for the use of coverings or other means for maintaining a satisfactory temperature for hydration. Calcium chloride incorporated in the concrete mix has been shown to be of particular value as an accelerator and as an agent to insure moisture for satisfactory curing.

In considering the effect of calcium chloride as an accelerator of the setting of cement it is interesting to note results of studies reported by the Bureau of Standards (Fig. 8). It will be seen that the maximum temperatures of the cement paste with varying percentages of calcium chloride are approximately the same; the time in which these maximum temperatures are attained is materially reduced by the addition of calcium chloride.

If a reasonable length of time is provided before temperatures may start lowering the use of calcium chloride will insure sufficient acceleration of set of the cement (which increases the early temperature of the concrete accordingly) so as not to require special protection of the concrete so long as the temperature does not go below freezing—and then only if the freezing temperatures prevail for some time.

Calcium chloride in the concrete mix does lower the freezing point of the mixing water; however, the amount recommended for use as an accelerator is not sufficient to be of particular importance in this regard. The value of calcium chloride in concrete is its accelerating action on the setting of the cement. Many years ago when the use of calcium chloride was first studied there was considerable variation in the constituents of commercial cements and it was advisable to make tests to determine the amount of calcium chloride which should be used and the extent of the acceleration to be expected with the particular cement being used on the project. Results of recent tests made by the Bureau of Standards and reported at the last meeting of the Highway Research Board (Fig. 9) show that practically the same accelerating effect is produced on eight standard portland cements of as widely varying constituents as could be obtained. This proves that it is practicable to write a specification for the use of calcium chloride in concrete for winter construction stating a percentage of calcium chloride to be incorporated that will apply to the use of all cements—and without the requirement of special tests.

The use of high early strength cement is of considerable value in overcoming the effect of low temperatures, due to its rapid rate of hydration, and its use in place of standard portland cement and calcium chloride or of additional standard portland cement and calcium chloride is a matter of economic consideration.

The use of high early strength cement together with calcium chloride produces very marked results in the early strength of concrete even when it is placed at very low temperatures and without special protection (Fig. 10).

When temperatures at the time of placing concrete are near freezing and remain low the use of either high early strength cement or calcium chloride or both must not be entirely relied upon to insure proper setting of the concrete. Temporary enclosures of canvas heated with salamanders or the covering of pavements, sidewalks, etc., with at least a six-inch layer of straw uniformly distributed and held in place with a canvas or burlap, must be provided.

Heating of the mixing water is effective in raising the temperature of the concrete, as is also the heating of the aggregates. Whenever freezing temperatures prevail the aggregates themselves are likely to be frozen and must be heated to insure against the incorporation of lumps of frozen material. A further application of heat than is necessary to thaw out or prevent these materials from freezing will be of very definite value in increasing the temperature of the aggregates and, therefore, that of the concrete.

Tests on specimens of concrete made at the construction site and left to cure under as near as possible the same conditions as the concrete in place, offer a definite means of checking the quality of the concrete. The small specimens will be more affected by the temperature

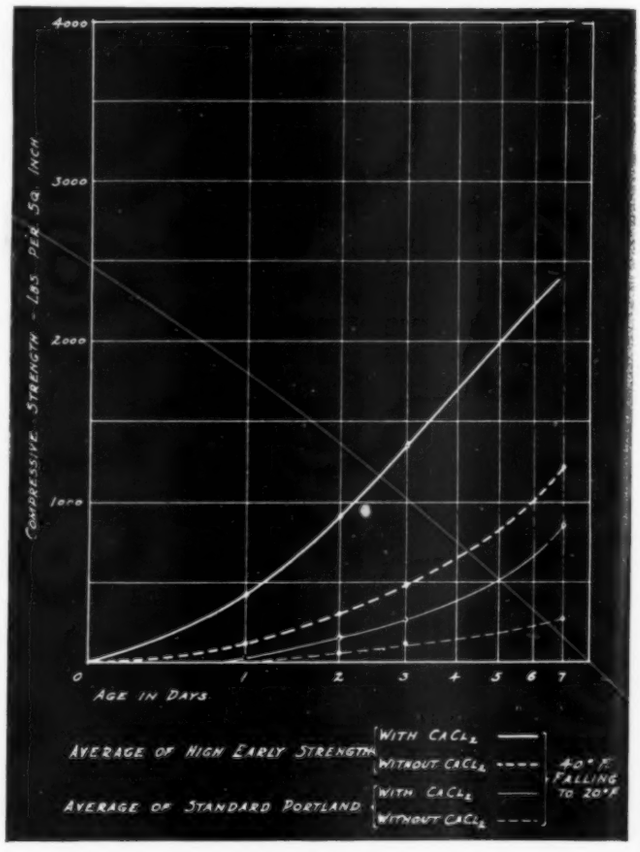


Fig. 10

changes than the larger mass and therefore if a satisfactory rate of hydration is indicated by the results of these tests it is assurance that satisfactory curing of the construction concrete is taking place.

If the Public Works program is to be a success not only must all branches of the Government coöperate, but everyone in charge of construction must realize the importance of keeping each project working to the maximum. The carrying on of concrete construction is one of the greatest factors to this success. That this can be done satisfactorily in cold weather, if careful consideration is given to necessary protection during the curing period of the cement, has been fully demonstrated by actual practice.

Not only is it worth while giving particular consideration to this matter on account of immediate labor conditions, but continuance of construction work the year round in place of 8 or 9 months of the year is a most important factor affecting permanent prosperity.

Acknowledgement.—The foregoing is a paper presented Jan. 24 at the Convention of the American Road Builders Association.

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PLANNING COMMISSION APPOINTED IN MICHIGAN.—A State Planning Commission, designed to formulate both immediate and long-range public works programs for Michigan, has been appointed by the Governor. All phases of public improvements are to be studied.

Machine Construction of Black Top Surface on a New York State Job

By H. C. Hill
District Engineer, The Lane Construction Corporation

IN 1932 the State of New York let a contract for building a road, part of which was in Schoharie County and part in Montgomery County. This road began at a point on U. S. Route 20 at Sloanville and extended northwesterly 8.73 miles to Roral Grove where it then connected onto a highway already existing, which was about four miles from Sprakers on the Mohawk River Highway, Route 5S.

Since the road was completed and even during the latter stages of its construction, it had numerous inspections by engineers and very many favorable comments were made on the exceptionally smooth riding qualities of the road.

The type of road up to the final surface material was similar to many that New York state built up to 15 years ago but since which time only a few have been constructed, namely, a foundation course of field stone and a bottom course of crushed stone plus a cold mix black top surface.

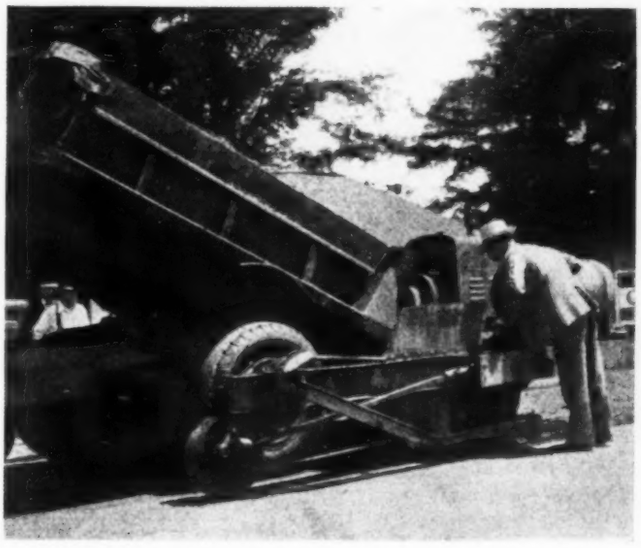
Construction of Foundation and Base.—The very satisfactory result obtained was due first to provisions taken to be certain that each course was true to line, both longitudinally and transversely. The soil was of a clay nature, hard when dry and soft when wet, and seemed to take an unusual length of time in setting. For this reason the foundation course was not laid until the subgrade was stable.

This foundation course consisted of field stone 9 in. thick when compacted, filled with crushed stone and screenings. The field stone were mostly sandstone, which due to its brittleness made it easy to break the top projections, with a result that even this course rode smoothly. On top of this was laid a 3 in. course of macadam. Exceptional care by use of lines was taken to see that this course was laid true.

Construction of Surface.—The final surface material was a 2 in. layer of New York State Specifications Bituminous Macadam Mixing Method Type 3, 1½ in. of coarse aggregate, and ½ in. of fine. This material is very similar to what is known as Amiesite.

The laying of this material was not started until 1933, the desire being that all previous courses should be in a settled condition. An Adnun black top paver was used for spreading the black top, which gave excellent results both from the state's point of view and from that of the contractor.

The material was delivered by trucks from the mixing plant of the Cushing Stone Co. at Schoharie, N. Y., with an average haul of 12 miles.



The paver runs by its own power and needs no forms. In operation, the truck hauling the material dumps into a hopper on the machine in which a series of revolving blades rotate, causing an even distribution of the material onto the road, where it is spread smoothly by screeds, these screeds being readily adjustable to any desired depth. Moreover, there is also what is known as a cutting edge which forms the side of the material into a vertical plane.

The motive power is a

Construction Views Showing Laying of Surface with Adnun Black Top Paver

gasoline engine so connected to all moving parts of the machine as to be operated by levers handled by one man. The machine travels on four small wheels with pneumatic tires with a wheel base of about 10 ft., and this length of wheel base is the means of taking out small depressions. This particular machine would spread any width up to 10 ft. by simply inserting partitions in the hopper.

After a little preliminary work it was discovered that it was advisable to form an earth shoulder on the outer edge by laying a 2 in. plank on the macadam base and placing the earth against it, moving the plank ahead as soon as the shoulder was built. This served two purposes: first as a guide for the operator of the machine to obtain a straight line, the outside wheels of the machine just touching the earth shoulder; second to prevent the material from feathering out if the weather was warm when the power roller came along.

It was also found advisable to stagger the width of the two courses: If the base on the first half was laid 10 ft. wide the top was then laid 8 ft. and on the second half just the opposite, the road being 20 ft. wide.

Besides the one man operating the machine the total number of men required for the completion of the spreading varied from one to four, more being required on the second lane than on the first as it was impossible to have the joining of the two lanes meet at all points, a deviation from a true line by the machine causing a similar deviation at the joints; if overlapping occurred it was necessary to remove slight excess material while if a gap occurred it had to be filled with additional material.

The time it took to spread an 8-ton load of the bottom course which was 1½ in. thick, would vary from 5 to 10 minutes and the time for the top course, which was ½ in. thick, from 9 to 14 minutes. The greatest variability was due to the mobility of the material, which of course depended upon the atmospheric temperature, the amount of fluxing oil and the elapsed time between mixing and use. However, the machine always spread satisfactorily no matter how stiff the material was. No trouble was had in spreading on a 9 per cent grade.

The work was under the supervision of L. D. Brownell, District Engineer, Utica, N. Y., with Joseph Morelli, Resident Engineer. The contractor was the Lane Construction Corporation of Meriden, Conn., with Martin Flynn, Superintendent.

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Minnesota Counties to Save Million a Year on Roads

Minnesota counties will save more than one million dollars a year from now on by being relieved of maintenance and improvement costs on the 4,500 miles of county roads taken into the state trunk system in January. This is the estimate of the state highway department.

The average county expenditure on the heavily traveled roads which were generally added to the state system has been about $200 a year for maintenance alone, according to highway department engineers, although this figure varies considerably in different localities.

As all these roads also require frequent outlays for improvements and betterments in addition to maintenance, the savings to county taxpayers should run far higher than a million dollars a year over a period of several years.

The state highway department must maintain and improve the new routes from its regular revenues. This year it has a trunk system 11,300 miles in length to care for, compared with only 6,800 miles previously. The highway department reduced its expenditures in 1933 by more than 50 per cent, compared with 1932.

"Vocational Guidance in Engineering Lines"

Reviewed by R. D. Rader, State Highway Engineer, Helena, Mont.

This book is sponsored by the American Association of Engineers and was edited by Dr. J. A. L. Waddell, assisted by Frank W. Skinner, Harold E. Wessman and others.

The publication of this book is undertaken on an absolutely altruistic basis, none of the authors or editors receiving any pay for their work. There are sixty chapters, each one dealing with some special branch of engineering and written by one of the leading specialists in that line. It is, therefore, the only authoritative book covering the subject of vocational guidance in engineering in existence.

The purpose of the book is to encourage the brightest, most active and most ambitious of the youth of the country to come into the engineering profession and to discourage those who are not fitted for this profession. It is not only of very great interest to engineers, but also to students of engineering and to those who contemplate entering a college engineering course. It is written frankly and honestly, with a view to placing before the engineering student the disadvantages of the profession, as well as its attractions and advantages.

This book should be read by every young man who contemplates the study of engineering and also by every engineering student. We believe that the reading of this book will save many flunk outs in college engineering courses, as well as present many misfits from entering the profession.

Vocational Guidance in Engineering Lines is published by the Mack Printing Company, Easton, Pennsylvania. Single copies postpaid $2.50 and in lots of 10 or more $2.00 per copy, including transportation.

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Shale Penetration Surface Course

A road having an experimental shale penetration course, built in Tamworth Municipality, New South Wales, is described in the January Highway Research Abstracts.

The road was built in 1933 as an experiment in the use of local materials on a ½ mile section of a highway carrying 300 vehicles per day. The original pavement was water-bound macadam.

After scarifying and reshaping, the road was sheeted with shale 4 in. thick. The spalls were of approximately 5 in. gauge. Rolling with a 10-12 ton roller reduced the shale to about 2½ in. gauge. About 15 per cent of the surface, in patches, was partially closed by fine material resulting from rolling and was only partially filled by the penetration tar which was applied after rolling at about ½ gal. per square yard. The average penetration was about 1 in. Two grades of tar were tried, the lighter grade being found more satisfactory on account of the presence of fines and the general soft character of the aggregate.

After penetration, river gravel (⅞ to 7/16 in.) was spread, 1 cu. yd. on 75 sq. yd., and rolled to consolidation. The seal was then applied, consisting of 175-225 penetration bitumen at ¼ gal. per square yard and 7/16 to 3/16 in. gravel at the rate of 1 cu. yd. per 80 sq. yd. The seal was rolled with a 10-12 ton roller using a wide broom in front of the roller. Several days rolling was done in warm weather resulting in a very good riding surface.

The total cost was approximately 40 ct.

Aerial Photographic Surveys
For Highway Right of Way Problems

By ALBERT ABRAMS

President, Abrams Aerial Survey Corp., Lansing, Michigan

AERIAL surveys divide themselves into three classes: Oblique photography, which can be transposed into line maps through a system of tapering grids. This system is especially valuable for reconnaissance purposes.

Multiple lens mapping, which uses special designed aerial cameras which are a combination of from three to nine cameras, so combined as to take not only a vertical photograph, but oblique photographs as well at the same time, which spread out to cover a large fan shaped area. This type of mapping has exceptional military value because large areas can be quickly covered and although the accuracy and detail are not comparable to single lens aerial maps, there is a very evident need for such line maps as can be compiled from this type.

Vertical single lens aerial mapping combines the highly developed type of photographic survey instruments into a science of definite formulas so now we go forward with a mapping operation with the assurance of definite results. The lenses are carefully calibrated by the U. S. Bureau of Standards and we know that by going to definite known elevations we will obtain accurate scales in the photographs. Highly sensitized aneroid barometers and recording barographs, calibrated to show elevations above the earth and compensated for temperature changes, are used to establish this height and we have recently been using two way radio communicaton to advise us of barometric changes as we operate aloft so that we may immediately compensate and reduce flying errors to a minimum.

Mapping Operations Carried on at Elevation of 2 or 3 Miles.—Most of our mapping operations are carried on at an elevation of from 2 to 3 miles high and the trend in the latest specification for government work is to operate at still greater elevations, the reason being that the higher we go the more territory can be taken in with a single strip flight, or photograph, and the more economical becomes the resulting aerial maps. Even from these great heights remarkable detail is obtained which can be enlarged to almost any desired scale. Still greater economy is possible in the drafting room where the information is taken from the photographs, because, with less individual prints to orient, the quicker and more economical becomes the office work.

Special film, highly sensitized, and color sensitive to the colors prevalent in mapping operations, is used together with long focal length lenses and aero filters which reduce the effect of aerial haze to a minimum. The planes are especially cut away to allow maximum visibility to pilot and photographer, special instruments are installed for flying and the motors equipped with altitude air adjustments and super chargers, also exhaust heaters for operations in zero temperatures.

This description of equipment is decidedly brief, and well it may be because in an aerial survey organization the airplane is considered as the necessary truck or platform from which we do our field work. The laboratory work necessary to complete the project and deliver to the drafting room a usable, accurate, and necessarily complete map is all important.

Accuracy of Map Negatives.—Map negatives as originally made are ordinarily accurate within limits of 2 per cent or 3 per cent. However, in the laboratory we have developed an instrument known as a distortion corrector which does three things: First, from the original negatives it enlarges or reduces the prints which are made to any desired scale; second, through the medium of tilting base on a universal joint all tilt is taken from the print; third, and most important, the map print to be made is projected on the inside curve of a bowl, the curve of which matches the curve of the lens in the aerial camera, the curve of the lens in the projection camera, and in this way all the distortion due to the curvature of the lenses is eliminated and the resulting prints are to a uniform scale all over. This is absolutely necessary and extremely important if accurate maps are to be produced. Humidity in the laboratory is very carefully watched to prevent unusual expansion or contraction.

If field notes, or reasonably accurate maps are available, this information is used when laying up the strip or mosaic maps. If no information is available, we go into the field and by ground methods secure a limited amount of measured distances sufficient for control and orientation. This information is then projected on our base to the desired scale and the aerial photographs made and laid to that scale. The result is that if there is any mistakes in the field notes, they are immediately noticed and corrected in the air maps and if there is an error in the air maps, they are corrected by the field notes, the result being a photographic map more accurate than either method alone.

Uses of Photographic Maps.—Accurate photographic maps have many uses for they show in clean cut photographic form all detail which can be measured and used in many ways. However, their utility is readily enhanced through the use of a "Contour Finder." Without exaggeration, it is safe to say that a "Contour Finder" will more than double the use and value of any aerial survey.

The contour finder is a stereoscopic instrument with magnifying lenses which gives about a four power magnification, enlarging the scale for ease in studying detail. It also doubles up the elevation allowing a very minute inspection of the contour of the ground, the height of trees, buildings, etc. Under the contour finder everything stands out in bold relief and appears as a solid relief model, fine in detail. All aerial photographs are made with a 66 per cent overlap in the direction of flight, this giving a complete set of stereoscopic pairs easy to handle and study. Using the contour finder, an engineer in the drafting room can complete a contoured map of exceptional accuracy with a very small amount of ground control. Every form of the ground is so faithfully shown in relief under the contour finder that a draftsman with very little experience and about a tenth of the vertical control ordinarily secured, can produce a contoured map directly on the photographic map in about one-tenth of the time generally necessary.

An aerial mosaic can be used in the office in much the same way as you would proceed with a survey in the field. The mosaic is oriented as to direction on the project and the azmuth carefully plotted from known ground

objects, instead of a transit, a protractor and conventional drafting instruments are used directly on the mosiac or prints. Under the contour finder relief is subjected to careful analysis, several preliminary lines are laid out. Sometimes an aneroid is used in the field to get control on the high and low points and the intermediate contour lines are drafted in by comparison. Using this small amount of field vertical control as a base, profile lines for comparative cost estimates are available and in the office a final line which only needs staking in the field is quickly decided upon. The advantages are many. Every possible location has been given consideration. The human element has been reduced to a minimum.

Several methods of use for photographic maps have been developed. Sometimes the individual prints or mosaic are taken into the field and used as a plane table into which property ownership and the very finest of measurements have to be added. Quite often photostat copies are used as field sheets, and again tracing paper is used to take off a line map of exceptional accuracy. Two things always attract the new user of aerial maps. First, the relief which can be seen and so easily studied under the contour finder; second, the ease with which laymen and engineers alike assimilate and readily recognize all topographic detail and accuracy.

The cost is always an important consideration and to make a general comparison is rather hard for it is just as easy to map the wild, rough forested areas or congested city as it is prairie country. Costs also vary depending upon specifications, etc. Prices will range, however, from 1 ct. to 10c per acre, depending upon the size of the area to be mapped.

Almost without exception the cost will average from one-eighth to one-tenth the cost of equal ground maps.

Aerial Surveys in Congested Areas.—Years ago they used to tell us that probably the greatest use for aerial surveys would be in wild, uninhabited country. However, it might be interesting to know that now a large percentage of this work is done in congested metropolitan areas where streets or curves are to be widened, or where there is a problem of primary or secondary belt line systems around cities.

Hundreds of aerial photographic survey maps have been made for many and varied purposes. In city zoning and planning, flood control, bridge location, traffic studies, street widenings, temporary and permanent rerouting, condemnation proceedings, aerial surveys have proven their utility. They are a highly specialized branch of engineering. They are not competitive to ground surveys and ground engineers. It is best to consider them as a new instrument which placed in the hands of a ground engineer, allows him to proceed that much faster and more efficiently and thus he is more valuable to any project.

Frequently it becomes desirable to exhibit special features, including elevations, on an aerial mosaic map to those who do not have the time or technical knowledge to make a study of the terrain with a contour finder. For this purpose it is convenient to have contours placed on the mosaic map to show quickly and easily points of equal elevation as well as to give a quick conception of the ruggedness of the country. By the use of a mechanical apparatus it is possible to place every accurate contours on an aerial mosaic. For many purposes such elaborate work is not necessary and a few contours sketched by means of a barometric level net will answer the purpose admirably. It is a relatively simply proceeding, one that requires only a small amount of extra field work.

Having established a level base or starting point, barometric elevations of the prominent features of the topography are obtained in the usual manner of barometric leveling. Such features would include the tops and bases of steep slopes, water level of lakes, points on streams, depressions between hills, such as pockets or small valleys, points along the edges of benches or table lands and other such features as can be easily recognized both on the ground and aerial map.

With these elevations taken in an orderly manner, and plotted on the aerial map, it is a comparatively simple operation to run the contours on the contact prints with the contour finder. A little practice with this instrument will enable the operator to judge points of equal elevation with surprising accuracy. Of course, the accuracy of the contour will depend on the accuracy of the barometric levels and on the number of points whose elevation is established by the barometer.

The manner of operation is somewhat as follows: With elevations established at the top and bottom of a regular slope, the points of the contours on a line between these elevations is obtained by simple proportion. This work should be done on one of a pair of contact prints. The prints are then placed under the contour finder and the contours traced out with a fine pencil. A set of prints which have a semi-matte finish are easier to mark than the usual glossy print. From the contact print the contours may be transferred to the mosaic by usual drafting methods. The more regular the topography the easier the task of plotting the contours. In choppy country, where contour lines will run very irregularly, it is also easy to locate the contours and, it can be done with reasonable accuracy.

Such contour work will produce a map which will be sufficiently accurate to illustrate, for non-technical people, those problems which an engineer has to present to them in a clear an convincing manner. It will also be sufficiently accurate for preliminary engineering work of many different kinds and in most cases no ground work is done until the final line is to be staked out on the project.

The aerial mosaic provides a true representation of the topography in two dimensions, length and breadth. With the aid of a contour finder the third dimension, depth, is placed at the command of the investigator. By the use of the contact prints, made from the original negatives, the contour finder reveals the vertical dimensions in a way that supplements and multiplies the value of the flat, two-dimensional mosaic many times. By its use the relation of the various topographic features are clearly shown. The magnifying lenses on the contour finder enlarge all three dimensions, so that the smallest objects become prominent. It is possible to trace out ranges of hills, follow valleys and pick out individual hills and valleys in broken country. The contour finder alone does not give absolute elevations but does give a comprehensive idea of the ruggedness of the terrain, in a way which surpasses all other methods. It will depend on the nature of the project as to how this information should be used.

By this study, the investigator can make himself surprisingly familiar with the details and values of the area under consideration before any expenditure for field examination is made. An aneroid barometer, portable copies of the mosaic map, contact prints, a contour finder with a sketching board to set it on, and a compass are sufficient working equipment to make a thorough field study of the area previously studied in the office. The office study has narrowed the area to be studied in the field to certain lines which appeared to be suitable for the type of improvement under consideration. The purpose of the field study should be to check the final lines considered to have favorable characteristics.

By this method of study it is not necessary to plunge more or less blindly into an extensive and often expensive field exploration of a large area with the little knowledge gained from incomplete or incorrect maps and be under the necessity of completing and correcting these maps. With the office studies made of the aerial map, the investigator starts on his field study with a very comprehensive idea of just where he is going and what he needs to do.

The use of the barometer, taking into account its limitations and proper methods of use, gives the investigator the differences in elevation between the low and high points in the terrain covered and, according to the requirements of the project allows him to take advantage of locations which are suitable or avoid those which are unsuitable. No field instrument work is necessary for orientation, recognizable object on the air map, being used as points of beginning and ground control.

For instance, the elevation of the crest of a dam may be determined and the contour of the flood water may be run out by taking elevations with the barometer on strategic points and these points connected by using the contour finder, so that the area to be flooded may be plotted on the mosaic map. By putting the land lines on the air map, the area may be studied by land ownership and right of way or water rights may be purchased without sending a survey party into the field.

Acknowledgment.—The foregoing is an abstract of a paper presented Jan. 24 at the Technical Session at the convention of the American Road Builders' Association.

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15-Ton Motor Vehicle For Railway Feeder

MOTOR transport vehicles especially designed for work in the British Dominions and Colonies as feeders for railways (thus doing away with the need for constructing branch lines) have been studied by the Oversea Mechanical Transport Directing Committee of London, England. A unit consisting of a tractor vehicle and two trailers, capable of handling a useful load of 15 long tons on lightly built roads, has been developed by the committee and tested both in England and in the Gold Coast. We are indebted to J. C. May, Secretary of the Committee, for its report on the tests of its first 15-ton unit. The notes following are taken from the report.

The Oversea Mechanical Transport Council and their Directing Committee were brought into being as a result of the recommendations of the Colonial Office Conference in 1927, and financed partly by contributions from twenty-three oversea Government and partly by the Empire Marketing Board. The chief aim of the Directing Committee was to put forward a vehicle, or series of vehicles, to carry a heavy useful load on earth or lightly constructed roads, the cost of operation and the damage to the road to be as small as possible.

Requirements for the Vehicles.—When the committee commenced work, the development of the large low-pressure tire had reached a stage at which it was possible to visualize a unit made up of a tractor carrying a proportion of the load, hauling two trailers, and thus capable of handling a useful load of 15 tons. In view of the problem of road maintenance it was obvious that the laden axle load must be kept low. The committee decided, therefore, to adopt a limit of 2¾ tons.

The committee drew up a general statement of their requirements for the tractor vehicle, which they submitted to Messrs. Leyland Motors Ltd., for execution. The main features of these requirements were as follows:

1. The axle load not to exceed 2¾ tons when carrying a useful load of 3 tons.
2. The vehicle to have 8 wheels, all driven, steered and braked; the system of suspension consisting of two 4-wheeled articulated bogies.
3. A large range of speeds to suit varied running conditions.
4. A cooling system such that no appreciable amount of water would be lost under the most strenuous conditions in the Tropics.
5. A petrol engine capable of hauling the gross load up a long gradient of 1 in 10 on earth roads with a loose surface. [The compression ignition engine had not at that time reached the commercial stage of development in motor vehicles.]

With regard to the trailers, the committee decided that the best method of spreading the load would be to utilize

Motor Transport Unit During Tests in the Gold Coast

two 4-wheeled articulated bogies under each vehicle. It was also specified that the trailers should be equally handy for haulage from either end and that fluid-operated brakes should be fitted, controlled from the driver's cab.

A limit was put upon the tare weight so that the laden axle load should not exceed 2¾ tons when carrying a useful load of 6 tons per trailer. The production of the trailers was entrusted to Messrs. R. A. Dyson & Co., Ltd.

The various requirements were met and that it was found possible to reduce the laden axle weight of the trailers to 2½ tons. The complete train of vehicles will, without reversing, turn in a circle having a diameter of 58 ft. Even when turning on full lock the trailers do not depart from the path of the tractor by more than a few inches owing to the way in which the front and rear bogies have been linked together. At the same time, the trailers are entirely free from "weaving" or swaying from side to side at anything above a nominal speed. To make it possible to maneuver the vehicles easily, the tractor is provided with a coupler at the front as well as the rear, and the trailers can be drawn from either end by changing over the drawbars. Arrangements have been made to enable the trailers to be maneuvered by hand in a confined space by means of a steering pole which can easily be operated by one man. Westinghouse brakes are fitted to the trailers and the single foot-brake pedal so arranged that the brakes operate upon the trailers before the tractor brakes come into action. There is thus no danger of the tractor being pushed round by the trailers when rounding a curve on a down gradient. Both the tractor and the trailers are fitted with a manual braking system.

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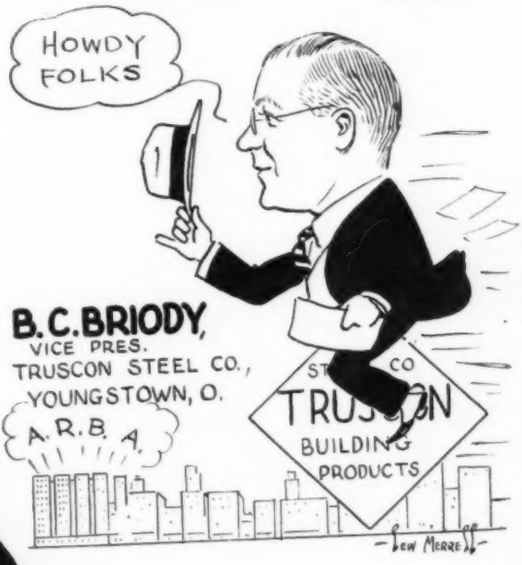

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INTRODUCED SPEED IN TRACTORS BY FEATURING BARNEY OLDFIELD IN A SERIES OF TRACTOR RACES AT COUNTY FAIRS

BARNEY SETS A RECORD OF 64.28 MILES PER HOUR IN A-C TRUCK

W. ELLZEY BROWN,
SALES PROMOTION MGR.—
TRACTOR DIVISION
ALLIS-CHALMERS MFG. CO.
MILWAUKEE

The radiator is mounted at the back of the driver's cab and is thus unlikely to be damaged, while it is out of the way of grass seeds when the vehicle is running on roads bordered by rank vegetation. The slow speed fan draws a current of air through the cab and therefore adds to the comfort of the crew when driving in areas of high temperatures.

Tests in England.—As soon as construction was completed, tests were commenced in England on unmetalled roads and tracks placed at the disposal of the committee by the War Department. During these tests, the unit covered 5,500 miles over unmetalled roads, carrying its full load of 15 tons throughout the whole of the period. The only repair work necessary was the refitting of a drawbar and the replacement of a faulty standard cylinder block. This caused a total loss of six working days.

Tests in the Tropics.—Having completed 5,500 miles in England, it was decided that the vehicles should be subjected to a severe trial in actual working conditions in the Tropics. The Gold Coast Government kindly agreed to allow these tests to be carried out in their territory. The unit was accordingly shipped to Takoradi on Feb. 3, 1933, and commenced running on regular service on March 6. Between that date and Oct. 28 last the unit covered 8,050 miles.

The 240-mile haul between Kumasi and Tamale was over hilly and undulating country, on lightly built roads having a surfacing of laterite gravel and occasional stretches of cotton soil embankment. In the first 60 miles from Kumasi the route crosses the Mampong and Ejura Scarps rising to heights of 1,500 ft. and 880 ft. above sea-level respectively. The ascent of the Mampong Scarp, some 30 miles north of Kumasi, is 4 miles long, with an average of 1 in 20, the route having a continuous series of hairpin bends. On such grades, whether ascending or descending, the unit was kept under perfect control without difficulty even during the rains, the bends being negotiated easily owing to the correct tracking of the trailers. For the next 25 miles the route is undulating with varying gradients up to a maximum of about 1 in 10. The Ejura Scarp is then encountered, and thereafter the road is more or less level for the remaining 180 miles.

During the first two months that the unit was in the Gold Coast it was dry season and the roads were extremely dusty. Between the months of May and September—the rainy season—practically all the work of the unit was carried out under wet weather conditions. It was found possible to operate it regularly often fully laden during this season, including periods during which conditions were such that it was impossible to run the standard 2-ton 4-wheeled lorries and light trailers employed on this route by the Gold Coast Government. The rainfall at Kumasic averages some 57 in. a year, while that at Tamal is about 42 in. a year. The working parts of the unit were not affected by the dust or the extreme wetness of the road. During the rainy season washouts on the road were frequently met.

The unit was working continuously in shade temperatures which varied from 85° F. at Kumasi to 104° F. in the Northern Territories, but at no time did the temperature difference between the cooling water and the air exceed 64° F.

None of the experimental features of the vehicles gave any trouble, working smoothly throughout the whole distance of 8,050 miles.

Ordinary commercial loads were handled, such as barrels of cement, concrete culvert pipes, timber, and bags of salt on the journeys northwards, whilst agricultural produce, including millet, kolanuts and cacao, as well as native passengers and livestock, comprised most of the loads on the southward journeys. As many as 150 sheep were carried on one journey.

An experiment was carried out in order to gauge the capabilities of the unit for carrying troops, and it was found that 100 rank and file of the Royal West African Frontier Force, with their arms, ammunition, and machine-guns, could be transported at once.

The unit arrived in the Gold Coast at the season of the year when there was little agricultural freight to be carried and when, owing to the general financial depression, there was a considerable decrease in the amount of freight offering for haulage northwards from Kumasi. Instead, therefore, of being able to secure a full load of 15 tons regularly in both directions, the loads worked out at an average of only 8.6 tons during the nine months' tests. Further, considerable periods were occupied whilst loads were being collected and distributed, with the result that the weekly mileage averaged only 237 miles. The figures provided by the Gold Coast Government show that in spite of these drawbacks the net transport cost of the freight carried is 11 ct. per ton mile. This cost includes every appropriate charge such as native wages, interest at 5 per cent per annum, depreciation on a five-year life or a mileage of 50,000 miles, insurance, tax, spares, and maintenance, fuel at about 30 ct. a gallon, tires, garage, and supervision. Had full loads been available for each trip or had there been no delays during the collection of freight, the cost per ton mile would naturally have been considerably lower.

The cost of fuel included in the above figure is entered at the average price paid for petrol at Kumasi. As compression ignition engines of the necessary size for the tractor are now established commercially, it may be of interest to record that the cost of gas oil at Kumasi is 16 ct. per gallon. Had a heavy oil engine been used, therefore, the cost per ton mile would have been reduced from 11 ct. to about 9 ct. under the same conditions of an average load of only 8.6 tons and a weekly average mileage of but 237 miles.

It was decided to terminate these tests at the end of October, 1933, and the Gold Coast Government has purchased the tractor and its two trailers. During these trials the unit was driven by a European driver.

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State Parkway System Planned for Minnesota

Minnesota now has the legal machinery for designating a state parkway system, part of which may be formed by roads in any county. Roads connecting a trunk highway with a public park or recreational center outside the limits of boroughs, villages or cities are eligible for inclusion in the parkway system. Parkway roads can be picked by county boards, subject to the approval of the commissioner of highways and the commissioner of conservation.

When officially designated as a state parkway, a road becomes eligible to receive both state aid and county aid benefits, at the discretion of the local board of county commissioners. Parkways are the only roads which can be both a state aid and county aid highway. State aid roads receive the proceeds of the state 1-mill road tax, while county aid roads receive one-third of the state gasoline tax.

Laws authorizing the establishment of state aid parkways in the counties were enacted by the special session of the legislature. In general, such roads will be subject to the same laws as state aid roads, but some special requirements and standards may be set up by the highway department.

Resurfacing Streets and Highways

An Address at Purdue Road School Containing Useful Suggestions on Expenditures of C. W. A. Funds by the Engineer of the Small City

By John S. Crandall

Professor of Highway Engineering, University of Illinois, Urbana, Ill.

THE subject of this talk is Resurfacing Streets and Highways. This is a topic that merits a good sized book to do it justice. There are so many miles of roadway that need resurfacing, there are so many types of pavement in those miles, there are so many climatic conditions to be met, there are so many traffic problems to be solved, and there are so many interests involved, that I can do no more than generalize on much of the work in the time allotted.

With funds available from CWA the cities are interested in improving their pavements right now. But if we inquire of the city engineer here and there we find that he just does not know what to do. Some would like to tear out the old pavements and rebuild. Others would merely like to repair what they have, while others would like to recover those pavements that are not in good condition. The question immediately arises as to how much money is available for materials and how much for labor. This may be the deciding factor. If you are restricted to 12.5 per cent of the total funds for materials you can do little more than repair work. If you can get an additional equal sum from your city you probably can do a fair share of resurfacing.

Let us look into the question of what the old pavements are like. What do we find to be resurfaced? Gravel, macadam (so-called, the most of it would make Mr. Macadam blush to think his name was coupled with such shoddy work), bituminous macadam, retread, bituminous concrete, sheet asphalt, cold mixes gone bad, brick, and concrete. All of these are to be found in Indiana. Can we satisfactorily resurface each particular type? Yes, if we go about the work carefully, thoughtfully, earnestly and honestly. What shall we use? We can use any type to resurface any other type, but such a procedure might well be as foolish as putting a new Oriental rug over the kitchen linoleum.

Retread Type of Resurfacing.—Let us start with our cheaper types, that is, the gravel and the broken stones. About a dozen years ago when I was consulting engineer for The Barrett Company, I introduced and developed what is now well known as the retread type of resurfacing. There are many miles of retread in Indiana. As its fond parent I am, naturally, rather proud of its record. Some changes in its materials and its construction have been gradually creeping in, but essentially it is the same as I started with. The mixed-in-place or retread idea was apparently wrong in theory, but in practice it works well. The original jobs were all mixed with tar, but asphalt is also used now. The tendency at the moment is to use heavier grades of bitumen than formerly. In the summer time this is possible if you are well organized and have sufficient forces and machinery to do the work quickly. The ordinary variety of highway official who starts out to do retread work for the first time had better keep to the less viscous materials, or he may find himself in serious trouble. During 1933 New York State has been doing these jobs with but one mixing. All of the stone is placed on one side of the road, where it is "shot" with about 8/10 gallon of tar per square yard of surface. The tarred stone is then spread out over the entire roadway and is turned once or twice. The road is rolled, and the surface voids are filled with ⅛ to ¼ in. stone chips. A seal coat of tar at ¼ gallon per square yard is applied, covered and rolled, and then a second seal coat is applied and rolled. The thought is that this method will seal the surface against water and provide a top that will last longer without surface treatments.

If a gravel road or a macadam is to be retreaded I always advise that after the holes have been filled, the bumps taken off, and the old surface is made reasonably smooth, that it be given a surface treatment of about ⅛ gallon per square yard of a light bitumen. This will keep the dust from mixing with the new material, and will also be of service if rain should fall before the new top is put on. Of course if you are going to retread an old asphaltic concrete, brick or concrete pavement you should make sure that the old surface is in condition to receive the new one. Waves, holes, bad cracks, and disintegrated places will eventually show up in the new top unless they are patched before the resurfacing begins.

Right here I want to forcefully call your attention to the fact that these retreads, mixed-in-place tops, or other similar jobs are cheap surfaces for light to medium traffic. They never were meant to carry heavy through traffic, and in the majority of cases they just won't do it. Every once in a while some misguided individual puts such a topping on Main Street and wonders why it goes to pieces long before he thought it should. Of course there have been some miracle jobs with retread that have stood up wonderfully well under really heavy traffic, and their makers boast about them. But on the whole they are meant for secondary roads, and in such locations they give excellent service for little money. Of course there are many miles of mixed-in-place jobs right now that should be resurfaced by using the same method. In this way you build up a well bound road surface, reasonably thick, that may, some day, almost be a real pavement.

Penetration Macadam.—So much for this type of top. There are many others that can be used for the old gravel and macadam roads either in city or country. The penetration bituminous macadam is next on the list. It is inexpensive, and, properly laid and maintained it gives a good account of itself. Notice, however, that I specifically said properly laid. I believe that penetration roads have often earned a bad name because of the carelessness of construction rather than any other one thing. There has been too much taken for granted, and too little study on the part of the builders. Slipshod methods have produced miserable results. We are seeing now the promotion of penetration cement macadam. So, whether you use asphalt, tar or cement for the binder in your penetration macadam, see to it that no chances are taken in construction methods. If you do not know how to go about it do not be ashamed of your ignorance—there are millions like you—but get a representative of the company that sold you the binder to stick with you until you do. There are many books on the market that explain it all, and there are numerous excellent pamphlets put out by the materials companies that go into more detail than

most of the text books. Get these and study them carefully and thoroughly before you begin to spend money. If you will do this you will really be able to build a good penetration macadam that will last for years and years with little upkeep.

Higher Types of Gravel Street Resurfacing.—Gravel streets in towns may be resurfaced with higher types than these I have been explaining, provided the gravel is well consolidated and at least 10 in. thick. Such a gravel makes a substantial base for asphaltic concrete, brick, or concrete tops. But it must be remembered that in towns, and perhaps in villages, too, you must make allowance for raising man hole covers, catch basins, inlets, utilities box covers and so on. Resurfacing with these expensive materials is not a haphazard affair, and your estimates must include all of the extras I have mentioned, as well as others that may come into the local picture. You must ever keep in mind that if you are going to resurface a gravel or a macadam street with asphaltic concrete that the new top must not be of less thickness than 2 in., and preferably more than that. Brick will require at least 3¾ in., and concrete at least 5 in. Hence, look to your curbs and gutters, street intersections, and manholes.

Many of the old gravels and macadams are highly crowned. In this day of high speed we do not like that. Under the provisions of PWA and CWA it should be a simple matter to remove these objectionable crowns with hand labor. In fact much of the cost of the new top can be charged off to this kind of work, and indeed must be so charged if the labor costs and materials costs are to balance properly. Of course, if the old crown is removed, the flattened roadbed may then be too thin at the center. This should be carefully ascertained by digging through to the subgrade in several places. It will not do to resurface an old gravel road from which you have removed most of the gravel.

Resurfacing in Winter Months.—The question has arisen, especially in the CWA work in Chicago, as to the most suitable type of resurfacing for winter months. As a matter of fact there is no type that is good to lay in extremely cold weather unless it be some form of block pavement such as brick, stone block, or asphalt block, and even these might not prove to be satisfactory if the filler for the joints is to be a bitumen or cement grout since the former would chill so quickly as to fail to enter the joints, and the grout would freeze before it set. It is possible to lay two types of bituminous pavement in rather cold weather. Asphaltic concrete may be laid provided it reaches the job promptly from the mixing plant and is spread and rolled rapidly. However, if irregularities develop during the laying it will be next to impossible to roll these out before the mixture has chilled so much as to be unmanageable. The other type is a cold mix made with a cut back tar. Here I suggest that the solvent be increased sufficient to reduce the viscosity considerably below that normally used for summer work. One trouble with this cold mix is the procuring of dry stone, which may be more or less difficult in winter weather. These cold coal tar mixes may often be used where the asphaltic cut back mixes are not workable. Care must be taken with them to insure a seal coat early in the spring to seal the surface, and repairs must be made during the winter as often as may be necessary. And that may be often if your workmen are unfamiliar with the work, as most of these CWA men are.

In the Chicago area paving has been going on since the first of December. The work consists of resurfacing about 600 miles of old macadam and bituminous macadam with asphaltic concrete. These old macadams vary in thickness from 6 to 15 in., and their cross sections are those of the gay '90's.

Resurfacing With Brick.—If gravel or macadams are to be resurfaced with brick there should be some brain work done before starting operations. Most certainly the old, high crowns must be eliminated. Now, your old timer will say that that is esay—just do it with a sand cushion. And I say that any one who does that should be jailed for life. The sand cushion has been the ruination of more brick pavements than anything else. It would be possible, of course, to make a slush coat of sand, cement and water, as Illinois does for this work when resurfacing with brick over worn concrete, and strike it off, let it set, lay a mastic cushion on it, and then lay the bricks. Carefully done I think that that would be the best scheme, but perhaps a cheaper and nearly as good result would be obtained if the old surface is scarified along the center to remove the crown. Then roll well, building up the sides where necessary with what you take off the center. On this new surface spread a mastic cushion made with sharp sand and a suitable bitumen. This cushion should not be more than 2 in. thick as a maximum, and not over 1 in. on the average. My laboratory experience, dating from tests made in 1914 and my field work in the past three years show conclusively that this mastic cushion should be made with 93 per cent sand and 7 per cent bitumen by weight. The brick are laid directly on the cushion, rolled, and the joints filled with suitable filler.

Of course the old road can be resurfaced with a regular concrete pavement, in which event an excellent result should be attained since the concrete would have a fine substantial base under it. If the old macadam is highly crowned then the pavement laid thereon will have a naturally thickened edge. Two such pavements that I have watched have proved to be highly satisfactory.

Resurfacing Bituminous Macadam or Bituminous Concrete.—So far I have talked solely about resurfacing old gravel and macadam roads. There are many other types that may require resurfacing. What shall we do with a bituminous macadam or bituminous concrete that needs resurfacing? First of all carefully repair the old top, making the patches level with the rest of the pavement. Bumps or depressions will show up later if you resurface with any bituminous type. Now resurface with any method you like. But, if you use a bituminous top do not skimp on thickness. I do not care what any salesman for any material tells you about being able to get a good job with his material laid 1 in. thick. It just isn't so. A thin bituminous resurfacing is about as lacking in substance as a thin pie. Neither one will give you satisfaction. If the job is in town and you lay a 2 in. resurfacing you may find that the gutters are not deep enough. You may skimp a little in thickness along the edges, say for a foot and a half back from the curb, and so get sufficient depth to carry off the water. You may lay brick, or asphalt block over the old pavement with good results. Or again you may obtain excellent results with concrete.

Resurfacing Sheet Asphalt.—Frequently we find sheet asphalt that has gone bad for sundry reasons, and we wonder what to resurface with, especially in those localities where there is no asphalt plant now in existence. Usually the sheet was laid on a concrete base, and if you tear it up you find that the concrete is badly shattered or cracked. What to do?

Of course the base must be repaired before anything else is attempted. The pavement may be resurfaced with any one of half dozen materials. For instance, a cold plant mix of aggregate and asphalt, such as Amiesite, or coal tar and aggregate, such as Tarvia-Lithic, is easy to lay, and will give a good account of itself. If either of these is used the holes in the old pavement must be mended before the new top is laid. Another material is

asphalt block, provided there is a plant near by so that freight rates are not too high. Rock asphalt, such as Kyrock, has been used to advantage in such work. Paving brick is suitable, and if the old pavement is well patched before the brick are laid you should get a job that would last for generations. There is no good reason why concrete resurfacing should not be satisfactory provided the thickness of the concrete does not interfere with intersections, curbs, and inlets. E. M. Fleming of the P. C. A. says that "Over flexible or badly broken base pavements, a thickness of 5 in. is desirable. Resurfacing thinner than 4 in. is only satisfactory for strictly residential streets carrying vehicles of light weight, or where the base pavement is new and unbroken." Of course on rural highways 5 in. would mean nothing, but in town considerable care and ingenuity would have to be exercised to avoid unpleasant dips at street intersections, and the cost of resetting curbs, manholes and inlets must be counted.

Sometimes these old sheet pavements were not laid on concrete, but rather on old stone block, brick, or anything that was handy. They may have been, and probably were resurfacing jobs, originally. The resurfacing of a resurfacing of a poor pavement is something I shall not attempt to describe here, other than to say that a good scarifier and power shovel are the best implements to use.

Of course if there is a mixing plant at hand the most sensible way to resurface a sheet asphalt pavement is with sheet asphalt. Occasionally it is possible to obtain a semi-portable plant if there is no permanent plant at hand.

Relaying Old Brick.—Brick pavements may be surfaced by any of the preceding methods. In addition another scheme that sometimes works well is to remove and clean the bricks. Repair the foundation, lay a mastic cushion over it, and then relay the bricks with the reverse side up. There will be a loss of from 15 per cent to 30 per cent of the old bricks, and these should be replaced with others of similar size and color. The new bricks should be laid in their own area, as it is not good practice to mix the old with the new.

I have seen some very good examples of concrete over old brick, and I have seen some that are not so good. The latter are generally due to too thin a resurfacing, and to defects in the old pavement that were not attended to. There is an example at Urbana, Ill., that is interesting because the concrete was laid over a worn brick pavement, and I am told that the concrete varies in thickness from about 2½ in. to nearly 7. One item that is worthy of note is that where the resurfacing is thin there was evidently some difficulty experienced in keeping the reinforcement at the same level, with the result that it sticks through the surface and in some places has had to be cut off as it was poking holes through tires.

There seems to be a diversity of opinion among engineers as to the propriety of laying concrete directly over the old brick. Some hold that a cushion of a sort should separate them. I have seen jobs where the brick was given a surface treatment with tar, and the new concrete laid thereon. I have seen others where the brick were simply well cleaned, sprinkled with water, and the concrete laid. I have found no difference in the resulting pavements. Therefore I have no answer to this.

A worn concrete pavement makes an excellent foundation, usually, for all types of resurfacing. Any of the preceding methods may be used, if certain details are attended to. If brick is to be laid over old concrete, then it is highly desirable to widen the base by the addition of concrete curbs against which the brick may be laid. Of course this is not necessary if the brick are grouted. Such a curb is advisable for bituminous types.

Concrete over concrete is popular. Here again it will not do to skimp the job. If you feel able to spend the money necessary to lay a concrete pavement why jeopardize the result by making the new top too thin? In general it has been found satisfactory to lay 5 in. thick. There have been a few 3½ to 4 in. tops that have given good results, and there have been many more that have not. If you are going to do the work do it thoroughly and well. Put on 5 in. of concrete and reinforce it with small steel members closely spaced. I believe in the use of transverse joints at less than 30 ft. intervals. These should be carefully dowelled. I also believe that a center joint is necessary, with adequate design for the transfer of load across the joint. While these joints add to the initial cost they reduce the maintenance and repair bills. Therefore it will be well to use them.

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Road Builders See Roman Road Model

A day on the Appian Way, the most famous road of ancient Rome, was visualized in the large model of a Roman road exhibited at the 31st annual convention of the American Road Builders' Association at the Stevens Hotel, Chicago. This model showed both the construction of the road and the traffic on the highway. It was prepared by the Bureau of Public Roads, U. S. Department of Agriculture, after investigation as to the design of this most famous highway in history, typical methods of construction, and the various types of traffic served. The model will be located permanently in the National Museum in Washington.

The Appian Way, one of the main roads in the great system of highways that kept Rome in immediate contact with all parts of the Roman Empire, was studied because of the universal respect of all nations for the durable roads that were a part of the glory of Rome in the ancient world. The forward march in the science of road building is illustrated in the eternal Roman roads, which, however, would be regarded today as wasteful because they would cost six times as much as the wide modern highways for heavy traffic.

This road which endures after twenty centuries was 16 ft. wide with 2-ft. curbs 18 in. high on both sides beyond which were 8-ft. side roads. The Appian Way was of solid stone and concrete masonry 3 to 4½ ft. thick, depending upon the soil on which it was laid. It was very straight, with steep grades and the curves widened as on modern roads.

In building the Appian Way, a bed of sand and gravel sometimes covered with a thin coat of lime mortar was used as a foundation for the four layers of masonry. The first masonry layer, from 10 in. to 2 ft. thick, was composed of stones that would fit in a man's hand held together with lime motar or clay. The second layer of smaller stones mixed with lime motar was 9 in. thick. The third layer was of concrete made of small stones, sand and hot lime mortar 1½ ft. thick in the center and a foot thick on the sides to give a crown to the road. The fourth or wearing layer was of polygonal stones about 3 ft. in diameter and 6 in. thick laid with close joints. The upper surface of the wearing stones was dressed smooth and the joints fitted so tight as to be scarcely discernible.

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First Contract Let for $10,000,000 Bridge.—A contract for nearly $1,000,000 has been awarded for approach work to the new Delaware River bridge at Philadelphia.

Winter Concrete Paving at Fort Wayne, Ind.

SHOWING its complete disregard for established concepts of old man winter, Ft. Wayne, Ind., recently completed a concrete pavement on a street leading to its new water filtration plant, while temperatures hovered between 24 and 48° F.

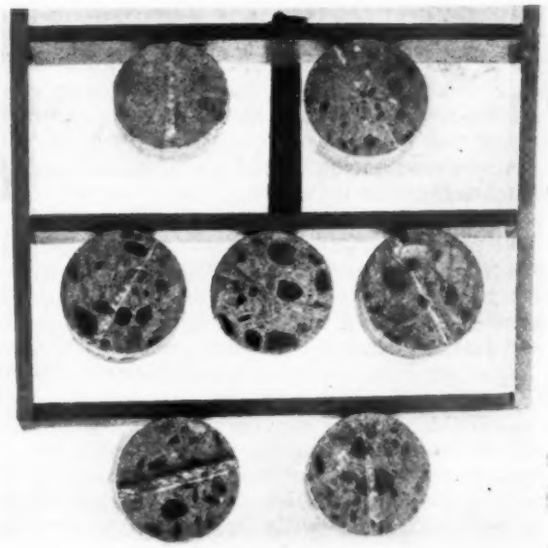
For years little thought was given to paving except in warm weather. With improved equipment, materials, supervision and organization the paving season has been

Immediately After Finishing Operations Straw Was Spread Over the Concrete

gradually extended. There are a number of cases where winter paving has been carried out successfully. And the example of Ft. Wayne is typical of a number of other such projects now under construction.

Ft. Wayne has a high standard for concrete. During the construction of every project by the Department of Public Works, the internal structure of the concrete is examined by the laboratory for aggregate particles position, density and texture. This examination is made from test cylinders taken at random from the job, and is in addition to standard strength tests. Established standards of the Ft. Wayne Department of Public Works were not lowered for this job.

Chief differences between the practice on this winter project and work in warmer weather were:



Test Cylinders Cut for Inspection of Structure of Concrete

(1) Subgrade was protected from freezing;
(2) Mixing water was heated;
(3) A Hauck standard mixer drum heater was used during mixing;
(4) Concrete was protected with burlap and straw until it was cured.

With a mixing water temperature of 85 to 100 degrees,

Test Cylinders Are Filed and Tested for Every Project

Regular Finishing Methods Were Followed Without Difficulty

and the drum heater, 70 degrees concrete was obtained. No additional premium was paid for winter protection.

There were 800 sq. yd. of 7 in. reinforced concrete in the job. The quality of the concrete is evident from three day tests, which showed compressive strengths of 1,500 lb. per square inch.

W. H. Droege is construction material chemist, in charge of tests. Coil Construction Co. of Ft. Wayne was the contractor.

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Four Highways Have New Type Lighting Units

A new type of sodium-vapor lighting unit has been installed along four highways in New England and New York so far this year, it has been announced by the General Electric Company. The installations are at Revere Beach and Newton, Mass., Wallingford, Conn., and Schenectady, N. Y. In New York City still another application has been made in floodlighting a building.

With a light output of 10,000 lumens, the maximum yet available for commercial applications, the new units require only as much current as that required by ordinary incandescent lamps having half their light output. Along with the introduction of the new type of lamp, the installations also incorporate the first application of a reflector of decidedly different contours from those regularly employed for directing beams of light.

Again, the installations also mark the first commercial applications of a new kind of reflecting material, a specially treated aluminum that possesses high reflectivity and a hardened surface that successfully withstands weathering.

At Revere, the new type lighting units have been applied in the illumination of the "cloverleaf" intersection of the Salem Turnpike and Revere Beach Parkway, 11 of the units being employed. The lamps are along one side of the highway, between 200 and 300 ft. apart, and about 20 ft. above the road surface.

Tests have shown that the curves can be driven with ease, even without headlights, and that there is sufficient illumination so that a newspaper can be read at a distance of at least 50 feet from a lamp.

Ten units have been installed at Newton, Mass., for the illumination of a section of the Boston-Worcester Turnpike. These units, 140 ft. apart, are at a height of about 22 ft.

Eight of the new lights are included in the installation at Wallingford, Conn., along Connecticut Route 5 between Hartford and New Haven. Here the units are 21 ft. high and 250 ft. apart.

At Schenectady, where the first installation of sodium lights along a public highway was made last summer, the original units have been replaced by eight of the new units. These are along the Balltown Road, in staggered formation, 250 ft. apart and 23 ft. high. So that tests of sodium-vapor and incandescent lighting can be conducted, a 10,000-lumen incandescent lamp is also mounted on each of the poles. It is an easy matter to switch from one type of lighting to the other for comparative tests.

The lamps which have been replaced with the new 10,000-lumen units, developed 4,000 lumens, and required both alternating and direct current. The new ones require only alternating current.

In New York City a different type of application has been made with the installation of four of the new units on the outside of the new General Electric Building, 570 Lexington Ave. at 51st St., where the golden glow of sodium-vapor light now floods the sidewalk and avenue at night. The units, mounted above the first floor level, represent the first application of the units for floodlighting.

These installations all include a new type of sodium-vapor lamp which, with an overall energy input of 275 watts or less, produce 10,000 lumens. (Incandescent lighting installations require 550 watts for 10,000 lumens.) The sodium-vapor lamp itself requires 240 watts or less, and the transformers and other equipment account for 30 to 35 watts.

The lamp itself consists of a long bulb of special glass enclosing at each end a coiled oxide-coated filament, which serves as a cathode, and an open-ended box of molybdenum, which serves as an anode. Each lamp, then, has two anodes and two cathodes. The anodes are connected electrically to one side of the filament coil so that only two conductors lead from each assembly. A small quantity of sodium and some neon gas are in the bulb, the neon being used to start operation. The lamp is about 16 inches long from tip to base, and about 3 inches in diameter. A double-walled evacuated flask of about 4 inches in diameter and 16½ inches in length is used with the lamp to retain the heat, which is essential for proper vaporization of the sodium.

To operate the lamp, each cathode is supplied with 10 amperes exciting current at 2 to 3 volts, supplied by auxiliary transformers or by auxiliary windings on the arc transformer. The lamp, rated at 6.6 amperes arc current, can, in the case of series circuit operation, be supplied from a transformer with 6.6 amperes or any other normal primary rating. Approximately 200 volts are required to strike the arc, after which approximately 27 volts are required to maintain the correct current. The high peak open circuit voltage obtained from the series transformer, which exists a very short time before the arc is struck, can be used to start the lamp. A device providing an inductive kick for starting makes it possible to obtain similar operation on a multiple circuit.

Since the cathode should be heated about a minute before the arc is struck, a time-delay device is incorporated in the luminaire to delay the starting that long. When used on a series circuit a film cutout is shunted across the arc transformer to cut out the lamp in case it does not start properly.

When the tube is cold, the application of starting voltage strikes an arc in the neon gas within the tube. The lamp then glows brilliantly with the characteristic red color of neon. Sufficient heat is soon stored up to vaporize the sodium, and the lamp gradually acquires the characteristic orange-yellow color of the sodium arc. About 30 minutes are required to build up the sodium light to maximum output.

The reflector used with the new type of lighting unit is outstanding not only because of its form but also because it marks the commercial introduction of a new type of reflecting material.

The lamps have slightly more than 100 square inches of light radiating surface, instead of the theoretical point source of incandescent lamps. This fact necessitates a reflector of decidedly different design.

It might be said that a leaf has been borrowed from aviation in the design of the reflector, for the upper part of the highly polished unit resembles an airplane in its lines. Below this surface are polished fins, one on each side of and parallel to the light source. These fins and the parabolic, cylindrical surfaces of the upper reflector direct the light along the length of the highway. The end of the upper reflector is also finished with a parabolic curve to direct the light across the highway. The fins redirect the light which otherwise would escape upward beyond the edge of the upper reflector.

EDITORIALS

Will Wages and Prices Rise Greatly?

THE government has spent about 100 million dollars bidding up the price of gold per ounce, in order to effect a rise in commodity prices and wages; but no appreciable rise has occurred, and none will occur as a result of gold purchases. Commodity prices in terms of currency are independent of commodity prices in terms of gold, as every great modern war has shown.

The President has announced his determination to raise prices and wages, in one way or another. He is now going to buy newly mined American silver, but this will have no appreciable effect on wage and price levels, for it will increase the total currency inappreciably.

The next experiment that he will probably make will be no experiment, for it will be out and out currency inflation, and experience shows that that is certain to cause a rise in both wages and prices. The process by which this will be accomplished has one element of novelty, namely, an arbitrary reduction in the weight of the gold dollar and governmental appropriation of the gold "profit" thus realized. If, as seems likely, the weight of the gold dollar will be cut in two, the government will "confiscate" about half the gold in the banks. Using this gold as a basis for paper money, the government could double the present amount of currency. Since this increased currency would soon be put in circulation, average wages and prices would rise. How much would they rise? About one hundred per cent above the level of 1929, unless currency deflation were to occur.

While governments have frequently inflated currency, there is no record of any currency deflation made voluntarily by any nation. Currency deflation can be effected either by raising taxes or by issuing bonds, neither of which is popular. By the time that it will be clear that the currency should be deflated to the present level, federal indebtedness will be the greatest in our history, and federal taxes will be staggering in amount. Under such conditions congress would have to be composed of men who cared nothing about re-election were it to vote a sufficient increase in bonds or in taxes to retire the inflated part of the currency.

The President's economic advisers have been silent on the deflation that should occur after inflation. Of course, they know that if currency inflation occurs, deflation must follow soon thereafter, or there will be runaway markets, a great boom and the inevitable collapse that follows. Perhaps they have planned an orderly deflation, but there is one factor which no amount of planning can control, namely, congress. The president controls congress now. Will he control it two years, or even one year, hence? We believe that he will be unable to convince congress that deflation should follow inflation of currency. Hence we forecast a wage and price level much higher than the peak of 1920. It is possible that it may reach twice that height, and it certainly will if per capita currency becomes double, and remains double, what it now is.

For the contractor there will be grave times ahead if our currency becomes greatly inflated, because both wages and prices may rise so rapidly as to ruin him before he can complete his contracts. The editor was caught in that sort of a maelstrom when he was in the contracting business, and the memory of it lingers.

For public employees times will be anything but pleasant if a great inflation in currency occurs and remains. Costs of living will rise faster than their salaries, exactly as happened during the boom that culminated in 1920.

However, prior to the peak of the next boom nearly all men now idle will be employed, and there will be years of prosperiy.

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Cyclic Variations in the Velocity of Light

TOPOGRAPHICAL maps of the ocean's bottom are being made by the aid of sound waves that are echoed back. May it not become possible to determine with accuracy the distances between "stations" on the earth by means of reflected waves of light? Possibly radio waves would serve this purpose better. Since the electrons in the earth's surface reflect radio waves, it may be feasible to make contour maps by the aid of radio waves.

Before either light or radio waves can be used satisfactorily for such purposes, more must be learned about the factors that affect their velocity. The density of the air is a well known factor that affects the velocity of light. But recent experiments in a mile-long vacuum tube have disclosed a very surprising fact, namely, that the velocity of light changes periodically, with an extreme variation of 12 miles per second in a cycle of about 14.75 days. This is so nearly half the length of the lunar month as to indicate that the sun and moon somehow affect the velocity of light along the earth's surface. There is a similar cycle of about a year, and there may be other cycles in the velocity of light. In a vacuum the mean velocity is now believed to be very nearly 186,274 miles per second. Presumably radio waves have the same velocity.

Since the earth is constantly emitting electrons, and since light is an electro-magnetic wave, it is probable that the number of electrons per unit volume of space affects the velocity of light. The emission of electrons from the earth is presumably not at a constant rate, and there is evidence that it is cyclic. Hence it seems likely that this may explain the cyclic variation in the velocity of light.

Several electron-shells encase the earth, and since they presumably rotate axially, they must be magnets. Being magnets they must not only attract magnetic materials in the sun and moon, but must also be attracted or repelled by any similar electron-shells that may encase the sun or moon. Since such attractions depend upon the direction of the axis of the electron-shell, it follows that there must be cycles in the attractive force. Hence there must be cyclic displacements of electron-shells. Such displacements would cause electron currents both in the earth and in the air. Therefore, electron density must vary, and it must vary periodically. It remains to be shown that the velocity of light is a function either of electron density or of the force of a magnetic field. If so, the puzzle of the cyclic variation in the velocity of light will be solved.

H. P. Gillette

County and Township Roads

A Section Devoted to the Interests of Those Responsible for Secondary Road Improvement

"Roads Over Which Mail Is Carried"

By W. G. ARMSTRONG

President National Rural Letter Carriers' Association

IT is not necessary for me to call to the attention of this well informed group that "Roads Over Which the Rural Mail Is Carried" embrace the worst roads in the United States. But perhaps it will be interesting for you to learn how acute is the desire of my association and its individual members to help remedy the situation confronting us, that of having 2,500,000 miles of unimproved mud roads out of a total of 3,200,000 miles of highways with 2,500,000 of the nation's 6,000,000 farms located on roads which are impassable at least part of the year.

No doubt your organization, just as ours, becomes dreadfully discouraged over the slow pace being made to overcome our mutual problem. But it is with pleasure that we can report as mail guardians of approximately one million and a quarter miles of roads that progress is being made, imperceptible as it may seem at times.

What Two Road Surveys Show.—Two important state road surveys have just come to my attention from our organization officials in Ohio and Wisconsin which bear out the foregoing statement. In Ohio the roads comprising 1,712 routes show 14,572 miles of paved road, 30,531 miles of improved and 9,304 of dirt. In Wisconsin, on 463 routes out of a total of 15,113 miles the division is as follows: Hard surface, 1,844; gravel, 7,907 and 5,361 dirt. Regardless of the fair Wisconsin road picture, however, out of the 463 rural carriers included in the survey 139 of them are forced to use snowmobiles, 278 horse drawn vehicles and 301 sleighs.

On the other hand there is a very dark road picture from the standpoint of the rural carrier, hundreds of whom personally assume responsibility for development and repair of their routes at an appreciable expense. For instance, in Illinois at Golconda we have a rural carrier who has to contend with roads which universally are admitted to be utterly unworthy of travel. As a matter of fact, a publishing house salesman, who owns two farms in Pope County where Golconda is located, recently averred that he can't drive the roads of the country for less than 15 ct. per mile.

Permit me here to say that regardless of this situation rural carriers have never been paid more than 4 ct. per mile for maintenance of the automobiles they must provide to serve their routes and during the recent economy program this has been cut to the ridiculously inadequate sum of 1 ct. per mile.

Car Maintenance Costs.—Furthermore, a regrettable situation, from the standpoint of the rural carrier, is the impossibility of convincing his superiors and his congressman, that his cost of equipment maintenance is considerably higher than any other comparable groups.

As a matter of fact, there are no other comparable groups. For instance, figures of the Bureau of Public Roads which are frequently cited as criteria, show a maintenance cost of 4.16 ct. per mile for the operation of passenger cars used throughout the United States in inspection work in connection with the construction of Federal aid highways.

These cars, numbering 219 and ranging from Fords to La Salles, are owned by the employes, but all operating costs, including depreciation, but no insurance, are paid by the Federal Government.

Over a period of ten years, accurately kept statistics show that these cars have been operated for 4.16 ct. per mile, and the fact that the Bureau of Public Roads have frequent reports of cars being pulled out of the mud indicate that they are operated on bad roads as well as paved roads.

Similar reports from large companies employing crews of salesmen who cover country districts and must also traverse dirt roads show a comparable cost of operation to that of the Bureau of Public Roads.

None of these operations can be comparable to that of the rural letter carrier. Highway construction is not carried on extensively during the winter months, and even in other seasons of the year, operations are necessarily suspended in the wake of big storms, from which few sections of the country are entirely free.

The salesman, when confronted with a sea of mud, may "hole up" for a day or so, or rearrange his schedule to cover territory over the better roads until the sections from which he has been temporarily cut off, have dried out and the roads have again become passable.

Rural Carrier Must Get Through.—But the rural carrier can not "hole up." He can not change his schedule. Neither can he rearrange his route in order to approach a specific place like the highway inspector headed for the scene of operations. The rural carrier does not

● This type is one of the oldest established pavements which has been used mainly on city streets and primary highways. It is easily repaired for service cuts, is low in maintenance cost, quiet, non-skid, and easy to clean and keep in a sanitary condition. It is used for resurfacing streets and for new construction.

It consists of a wearing course and a binder course, each usually being laid to a depth of one and a half to two inches, depending on traffic, on a suitable foundation of sufficient strength to suit the traffic.

The wearing course consists of a hot mixture of paving asphalt cement, mineral dust and sand:

Typical Mixture

	Per cent by Weight
Asphalt Cement	10.0 to 13.5
Mineral Dust	10.5 to 15.0
Sand	71.5 to 79.5

The binder course consists of a hot mixture of asphalt cement, sand and mineral aggregate.

Typical Mixture

	Per cent by Weight
Asphalt Cement	5 to 8
Sand	25 to 35
Mineral Aggregate	60 to 70

The foundation can consist of a newly constructed base course such as hydraulic cement concrete, asphalt cement concrete, macadam, or other types which have sufficient strength for traffic requirements.

STANDARD OIL COMPANY

(INDIANA) 132-A

910 South Michigan Avenue Chicago, Illinois

ASPHALTS FOR EVERY PURPOSE

have one specific destination. He has a hundred of them and sometimes many more.

Seldom can he deviate from his prearranged route. If the road is covered with a foot of water or 2 ft. of snow, he can not, under ordinary circumstances, detour and approach his destination from another direction. He has mail to deliver on that particular highway—if highway it may be called—and, the spirit of the service being what it is, the mails must go through.

And it is in this kind of weather, when the roads are blocked to all but the rural carrier, that his cost of operation soars. Mile after mile he must force his car through seas of mud, or drifts of snow, straining the motor, shaking the body, battering his fenders and twisting his wheels to make his daily rounds.

One such trip may shorten the life of his car by several months and often—how often—one such trip calls for a huge repair bill, the breaking of an axle, pulling out the read end and other heartbreaking experiences to which the rural motorist is subjected, but which are rare experiences to those not engaged in delivery of rural mail.

Secondary Road Situation.—The commendable fashion in which the American Road Builders' Association, through its Washington officials, keeps its hands on the pulse of the secondary roads situation is most gratifying to us. It was through Mr. Grubb that we were advised of the opportunity for road relief offered by the Public Works program. While we immediately admonished our members to place local roads projects before the proper officials unhappily we have not received reports indicating that any material headway has been made in this respect.

In Congress the battle to win help for the secondary road program continues to prove an up-hill fight. Regardless of the merit of the Summers farm-to-market road bill of the last Congress it never won a stage where it could be considered as having serious consideration. We hold, with you, however, that these defeats must be accepted as necessary stepping stones to final success, which inevitably must crown our battle in the end. While some roads experts might not agree with the belief of the former chairman of the House Roads Committee, C. C. Dowell of Iowa, we thoroughly subscribe ourselves to it. Chairman Dowell contended that he would rather see a 10-ft.-wide road stretch across the continent than to have concentration on 100-ft.-wide roads in our densely populated communities.

It was the privilege and pleasure of our Ohio State Association to work with Mr. Secrist, now congressman, to win legislation which might well be modeled by other states. This legislation requires a definite percentage of all appropriations to be assigned to unimproved Ohio mail roads.

In my own state of Michigan we have a system which surely and steadily is lifting our mail roads out of the mud. Each year Michigan adds 20 per cent of its township roads to the supervision of the County Road Commissioner with the ultimate objective of obliterating all township roads.

Acknowledgment.—The foregoing is an abstract of a paper presented Jan. 24 at the annual convention of the American Road Builders' Association.

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HEAT TREATMENT OF SOILS.—Experiments are under way in Queensland, according to the October Oversea Mechanical Transport Bulletin, London, in the use of a traveling furnace for heating natural soils of heavy clay as it passes slowly over the road. The fusible constituents of the soil are melted. The soil is loosened or dug in front of the machine to a depth as much as 16 in. After the heater passes, clay or other binder must be added and the surface can then be compacted. The machine in use prepares a strip 12 ft. wide.

The Paved Road and the Preacher

By WILLIAM G. MATHER, JR.

Cornell University, Ithaca, New York

WHAT happens when the paving gang has gathered up the machinery and gone home, leaving the "Danger—Soft Shoulders" signs behind it? Is it just a case of the contractor's pocketing another nice profit, and of the buses having another short cut between cities, or does it make a difference to the people who actually live along the highway?

There's a lot of room for speculation there. Suppose some farmer with a poor farm has been thinking of selling out to some other sucker, or just moving on and letting the sheriff have it; the paved road comes by his seedy place, ten miles from the nearest town; he puts in a gas and hot dog stand as a last resort. His very distance from town now becomes an item in his favor, and, as the cars and trucks fill up as they go by, he hears the pleasant sound of the mortgage lifting with each tinkle of the bell on his old hand pump. Prosperity has driven down the road to meet him. But then—there's the farmer's daughter, and the passing salesman, and all that. It has to be considered too.

Of course, it is impossible to measure exactly the social changes which a paved road makes in a countryside. We have always believed that it made them. Contractors have urged more roads, as a means of "bettering the life" of a community. But do they better that life, or not? Does it get better, or worse, or does it just stay as it is? A dirt-road community is often called a "backward" community; is it? Now and then some village preacher lambastes the automobile and the paved road as tools of the devil, to lure people away from church; is he right about it?

Last year, in the course of making a sociological study of 79 rural churches in a certain southwestern New York county, some facts were gathered which are of value to anyone trying to decide whether a paved road is a luxury, a necessity, or a curse.

They make good talking points to have handy when, in these days, we are trying to pare public costs down to the bare realities of life.

For instance, one little town of around 1,200 people, with perhaps a thousand more living on farms about it. We will call it Oil Spring. It has five churches now, and if one of these revivalists who travel about the country with a tent and a cornetist has his way, there may be six by the time you read this. It has a high school, to which children come for several miles around. To 107 young people in the upper grades of this high school we gave a questionnaire asking about their own and their parents' relations to the church.

We found that, within a four-mile radius of the town, the village young people had the closest relations to the churches; the paved road young people followed second; and the dirt road young people made third place—in some cases, a pretty poor third place.

Eighty-one per cent of the village young people were actually members of one of the five churches; 77.8 per cent of the paved road young people were church members; but only 65.4 per cent of the dirt road young people were members. The village young folks, of course, lived nearest to the churches and would be expected to have a high amount of membership; but note that the paved road young people are only 3.2 per cent behind

them, while the dirt road young people are 15.6 per cent behind them.

The difference is still greater when we consider their answers to the question, "Did you attend church last Sunday?" (The weather the previous Sunday, by the way, had been ideal.) 58.7 per cent of the village young people had gone to church; 44.4 per cent of the paved road; and *only* 19.2 *per cent of the dirt road.*

This Sunday was not an exception. For the next question on the list was, "About how often do you ordinarily attend church?" In answer to this, 66.7 per cent of the village young people replied that they attended on the average at least twice a month; 50 per cent of the paved road young people the same; but only 23.1 per cent of the dirt road young people went to church twice a month or more.

The same thing was true of Sunday school and Young People's Society membership and attendance; always the child who lived on a dirt road was at a disadvantage. The figures for Sunday school membership are: village, 63.5 per cent; paved road, 50 per cent; dirt road, 23.1. For Sunday school attendance: village, 42.9 per cent; paved road, 33.3 per cent; dirt road, 15.4 per cent. As to the Young People's Societies, 41.3 per cent of the village young folks were members; 16.7 per cent of the paved road; and 3.8 per cent of the dirt road. Attendance at the last young people's society meeting was almost the same for both village and paved road, being 17.5 per cent for the former and 16.7 per cent for the latter—while no dirt road young folks went to them the previous Sunday at all.

It cannot be said that these young people were at fault, rather than their roads; for we find that the ministers of the communities studied were reluctant to get out to the dirt road homes to call. For the entire county, ministers had called within the last six months at the homes of 65.5 per cent of the village young people; at the homes of 42.5 per cent of the paved road young people; but only at 38.4 per cent of the homes on dirt roads.

It works both ways, you see. The dirt-road child has trouble getting in to church to hear the preacher preach; and the preacher has trouble getting out to call on him.

A few years ago, J. L. Tennant made a study of the economic relationships between roads and agriculture in New York, and discovered that dirt roads have nearly five times as many empty houses as do paved, less regular mail deliveries, less modern machinery, fewer automobiles, and lower land values bordering them.

We can well add to this list, less religion. The paved road makes a difference to the preacher.

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Protecting Construction Lumber from Moisture Pick-up

Protecting the lumber pile on the construction site with a covering of building paper is a simple and practical method of preventing large moisture pick-up in shiplap, joists, and other structural items, it is stated from results of tests recently completed by the U. S. Forest Products Laboratory here.

In the case of ponderosa-pine shiplap, taken as representative of the nominal inch class of material, it was found that the use of lath stickering, together with a cover of building paper over the top and ends of the pile, produced the most satisfactory retardation of moisture pick-up of all the means tried. The same method was good for ponderosa-pine joist except that solid piling, because of the tendency of joist to lie flatter, offered less opportunity for the entrance of moisture and was more effective than stickering in slowing down moisture changes.

The following list shows, in order of decreasing effectiveness, the various piling methods used for the two items:

Shiplap	*Joist (all joints aligned)*
Stickered and covered	Solid piled and covered
Stickered, uncovered	Stickered and covered
Solid piled and covered	Stickered, uncovered
Solid piled, uncovered, joints staggered	Solid piled, uncovered
Solid piled, uncovered, joints aligned	

The cover paper referred to was of a moisture-resistant fibrous type, running in one piece over the top and overlapping the ends of the pile. To allow for shrinkage of the cover it was found desirable in the tests to tack only one edge of the top, holding the other edge with timbers resting on lath, as shown in the illustration. The paper should be held as tight as possible against the ends of the pile by lath held by driven stakes.

Method of Covering the Lumber

The tests supported previous experience in pointing to the need for foundations of some sort to protect the bottom layer of stock from ground moisture and surface run-off.

It was found that where it is impossible to provide a cover of any sort, stickering is badly needed if the storage period is a long one, inasmuch as moisture tends to emerge from such a pile far more slowly than it goes in. An uncovered solid pile will tend to build up moisture content even during a period of only occasional showers.

The period of storage in the recent tests was purposely lengthened far beyond the time that material would stand waiting on the average job, and by the best methods of piling and covering that were tried the average moisture content was effectively held below 16 and 18 percent for joists and shiplap, respectively, up to 450 days in the pile. Unprotected lumber, on the other hand, registered averages above 32 percent moisture content in the same time. The materials and practices used were kept down to a scale that might be economical on the small or medium-sized contract.

Commenting on the results of the paper coverage, J. S. Mathewson, Forest Products Laboratory engineer who has directed this and other lumber storage tests, pointed out that such inexpensive protection of dry lumber on the job will go far toward reducing structural shrinkage.

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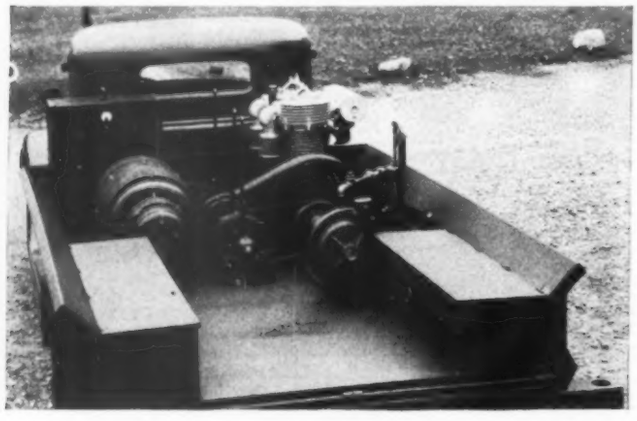
MEETING OF ASSOCIATION OF STATE HIGHWAY OFFICIALS TO NORTH ATLANTIC STATES.—The 10th annual convention of this Association will be held Feb. 14, 15 and 16 at the Hotel Ambassador, Atlantic City, N. J. A. Lee Grover, Trenton, N. J., is secretary and treasurer.

New Equipment and Materials

Power Take-Off for Trucks

A split shaft take-off for transmitting power from the truck motor for the operation of any mechanical equipment that can be mounted on the truck chassis has been brought out by the Ditwiler Manufacturing Co., Galion, O.

The standard power take-off is designed to operate from the driver's seat while truck is in stationary position. A special model is available to operate either while truck is in motion or stationary. Standard models are designed for heavy duty work and can be easily installed on any long wheel-base truck chassis regardless of motor size or truck rating. The installation requires only the cutting of the drive shaft and the addition of one universal joint and cross member, furnished with the take-off.



Power Take-Off Installed on Truck

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Machine for Eliminating Soft Stone from Aggregate

The constant tightening of specifications on concrete aggregate, especially for road and bridge work, has moved many material producers and the manufacturers of gravel plant equipment to seek new and better methods for eliminating soft stone from bank run material. One of the most recent developments is a machine designed and built by the Knickerbocker Co., Jackson, Mich., which is claimed to eliminate ochre, sand stone, sailers, chalk, lignite, etc., at a minimum cost and with a minimum breakage of good stone.

The equipment, known as the Knickerbocker soft stone eliminator, consists of a rotor revolving in a vertical plane within a suitable casing. The rotor is supported by a heavy shaft revolving in two roller-bearing pillow blocks. The impact bars of the rotor are of high-alloy, especially heat treated steel. The rotor is carefully equilibrated for both static and dynamic balance when assembled, to accommodate the required speeds without vibration.

In operation, the eliminator is introduced into the line of production after the sand has been removed from the bank run material. The stone is fed into the machine through the 15-in. opening on the charging side, goes through the unit and is discharged at the bottom, generally onto a sizing screen. While inside the machine, the stones are struck repeated blows of constant intensity by the impact bars, are carried up around the inside of the casing and are subjected to constant abrasion upon each other before being discharged. An inlet provides for the introduction of water and the pulverized soft stone runs off at the bottom in the form of a thick sludge.

Users of this equipment claim that it not only brings the soft stone content of their product well within specification requirements, but that this result is achieved at remarkably low cost and with a minimum waste in the form of good stone broken up. A 20 hp. motor runs the outfit, which has a capacity of from 50 to 90 tons per hour.

Knickerbocker Soft Stone Eliminator

New 4-Cylinder Air-Cooled Engine

Pronounced success with their single cylinder heavy-duty air cooled engines and a growing demand for air cooled engines of greater horse-power has caused the Wisconsin Motor Corporation of Milwaukee, Wis., to bring out a heavy-duty 4-cylinder air cooled engine of 6 to 16 hp. capacity. This engine is called model "AC4" and has a 2⅝-in. bore and 3¼-in. stroke with a piston displacement of 70.35 cu. in. The engine develops 10 hp. at 1350 r.p.m., 12 hp. at 1600 and peaks at 16 hp. at 2600 r.p.m. An outstanding feature of this model is its very light weight, the engine with accessories weighing only 215 lb. and the complete unit with house, gas tank, etc., weighing only 265 lb. The overall length of the complete unit is only 20¼ in. This unit has been particularly designed for the heavy-duty service of the industrial, agricultural and automotive fields, and because lightweight is very essential, materials of high tensile strength are employed to keep the weight down.

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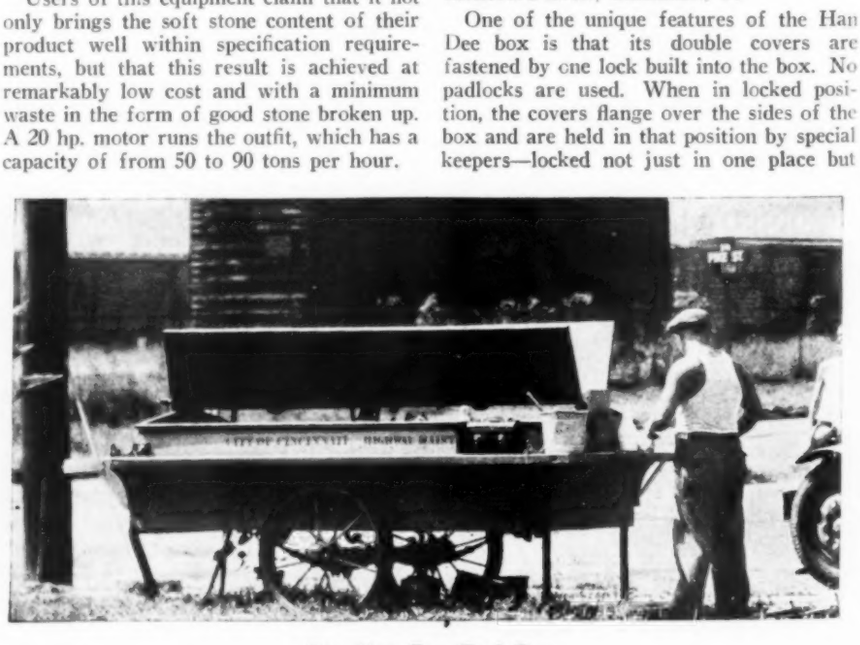
Steel Tool Box to Protect Tools

Lost, strayed or stolen small tools are a considerable source of loss on construction jobs as contractors and highway officials will testify. As a result of the CWA projects, thousands of small tools have been purchased by cities and towns and placed in the hands of men employed on these jobs. The protection of these tools is important. A steel tool box, which according to the manufacturers, is weatherproof, fireproof, and thief proof, is therefore of interest. Such a box is manufactured by Littleford Bros., Cincinnati, O.

One of the unique features of the Han Dee box is that its double covers are fastened by one lock built into the box. No padlocks are used. When in locked position, the covers flange over the sides of the box and are held in that position by special keepers—locked not just in one place but



The Han Dee Tool Box

full length of the box. The keepers must be shifted to release the covers—very much the same arrangement as is used on a safe!

In addition to the locking arrangement, both front and rear drop legs are fastened in position from inside the box; they cannot be released except by raising the tool box cover. Wheels and tires can be locked to the box so that it cannot be trailed except by those having a key to the box. When the box is locked up and left standing along the side of the road or in a field, it's there to stay until the foreman and his men come back. Without a key, you could not get into this steel box except by using a cutting torch!

Other features include a large compartment for picks, tampers, shovels, jackhammers, etc.; a sliding shelf divided for smaller equipment, first aid kit and records; lantern guards, semi-elliptical springs, Timken roller bearings and pneumatic or solid rubber tires finish off a tool box designed for highway departments.

Pneumatic-Tired Dump Wagon

A pneumatic-tired wagon of 15-20 ton capacity has been placed on the market by E. H. Anderson Equipment Co., 3918 S. Wabash Ave., Chicago, Ill. The wagon is

Anderson Pneumatic-Tired Wagon

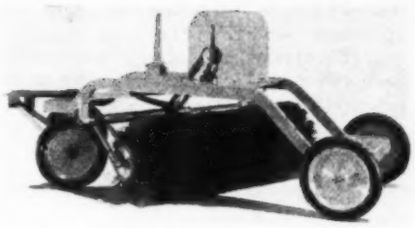
stated to be designed to meet the varied hauling conditions encountered in new construction, to operate efficiently in sand, muck or on paved streets—on a 200-ft. or a 2 mile haul—at speeds of 2 miles per hour or 20—without undue wear on any part of the chassis.

The Anderson pneumatic-tired dump wagons are easy turning units—in fact they will pivot on either front wheel. The two rear wheels castor so that there is no strain whatever on the chassis or wagon. A special device controlled by the tractor driver locks the castor wheels for backing. The Anderson chassis can be fitted to any crawler wagon in a short time. Various chassis and tires are available for the different size wagons.

New Sweeper

A sweeper that does not have to be rigidly attached to some other piece of equipment, but that can be hooked to or unhooked from a team or a truck or a tractor in no longer time than it takes to hook or unhook a regular four-wheel trailer, has been brought out by the Frank G. Hough Co., 919 N. Michigan Ave., Chicago.

The brush is independently driven from its own engine, and can therefore be regulated to revolve at whatever speed best suits the sweeping condition. The brush is suspended from a substantial steel frame



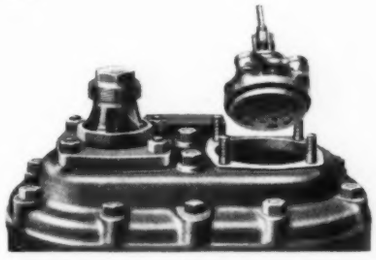
Hough-Universal Sweeper

which in turn runs on four pneumatic tires. This is claimed to give to the brush the same leveling motion as the blade on a grader, and the sweeper can be used for spreading and leveling gravel and aggregates on re-tread and road-mix paving jobs.

Its overall width is less than 8 ft. and its pneumatic tires and Timken bearings permit it to be pulled over highways at any speed and for any distance.

Changing Compressor Valves While Hot Avoids Long Shut-Downs

A removable valve assembly that is stated to cut the replacement time to 10 minutes is a feature of the compressors of the Curtis Pneumatic Machinery Co., St. Louis, Mo. This assembly permits changing of the valves while hot, thus avoiding the long wait ordinarily necessary while the compressor cools; and lost time for hammer and drill men is greatly reduced.



Removable Valve Assembly

Four bolts hold the assembly in place. Removing and replacing these bolts, and lifting out the hot assembly and setting in the spare, includes every operation of the change. The actual time of shut down computed for the operation is ten minutes.

Additional advantages of the removable assembly, mentioned by users, are in cleaning carbon and grinding valves. With the assembly out of the compressor, every part is accessible. The time required for repair is shortened; and a further saving in labor costs is made.

The Scintilla Vertex

The vertex, a new magneto of the Scintilla Magneto Co., Inc., Sidney, N. Y., is designed primarily for engines which have no provision for conventional magnetos. It is installed on the usual timer mounting of the engine and is driven in the same manner as the battery ignition timer which it replaces. Being a complete and self-contained ignition system, the Vertex generates its own high voltage electric current which it also distributes to the spark plugs. It is entirely independent of the battery.

Only the finest of materials and workmanship are used in the construction of vertex magnetos. The housing is cast from high grade aluminum alloy. The rotating magnet is made from finest cobalt steel which is one of the most powerful magnet materials known. Complete enclosure affords protection against dust, dirt, oil and water.

The Vertex generates a hot igniting spark over the whole operating range from extremely low speeds to high speeds far in excess of engine requirements. The Vertex facilitates starting. Being entirely independent of the battery it is unaffected by low battery voltage. It gives a hot starting spark even in the coldest weather. The vertex does away with the ignition load which drains the battery at low speeds.

Vertex magnetos are supplied with S.A.E. standard mountings for 4, 6, 8 and 12 cylinder engines. The 12 cylinder type weighs 7¼ lbs. and the other types approximately 6¾ lbs. They operate at one-half crankshaft speed and are therefore interchangeable with conventional battery ignition timers.

Recent United States Patents Relating to Roads

Compiled by Patent & Technical Information Service, 1336 New York Avenue, N. W., Washington, D. C.

NOVEMBER 7, 1933

1,934,073. **Aggregate Coater.** Alexander W. Knox, Indianapolis, Ind., assignor to Kenneth E. McConnaughay, Indianapolis, Ind. In a device for coating aggregate, a base mounted on wheels, a vat having front and rear walls sloping down toward each other, means for pivotably attaching the front end of the vat to the base, a frame supporting the opposite end of the vat, and a conveyor pivotably supported from and above the base with its lower end swinging adjustable in the vat, said conveyor having a plurality of buckets with perforate walls, and a floor under the conveyor removable therewith, a hopper above the vat, an adjustable gate in the hopper-discharge and a baffle under the gate adjustable relative to the conveyor and adjacent end of the vat.

1,934,488. **Road Maintainer.** Chas. B. Dempster and Herman M. Loeber, Beatrice, Neb., assignors to Dempster Mill Manufacturing Co., Beatrice, Neb. A road maintainer including a main frame support on a plurality of downwardly and rearwardly inclined scraper blades, each of said blades having a support secured to said frame to rock thereon, a slide secured to said frame to move forwardly or rearwardly thereon, a link pivotally secured to said slide at a point forward of said support and secured at the opposite extremity thereof to said support, and means for sliding said slide for adjustably altering the angular relation between said scraper blade and said frame.

1,934,550. **Pavement Form Spader.** Andrew A. McCree, St. Paul, Minn. In a pavement finishing machine having a screed provided with flared ends, spaders carried by the machine and extending in front of but adjacent to the flared ends of the screed, the spaders being adapted to pass through the pavement mix along the edges thereof to assure even contact between the mix and its lateral road forms after passage of the screed.

NOVEMBER 14, 1933

1,934,782. **Paving Construction.** Lytle S. Adams, New York, N. Y. A self draining surface construction for pavements comprising a sub-surface, a plurality of inverted frustro-pyramidal members arranged with their top portions in abutting relation and with their bottom portions set into said sub-surface and defining open drainage spaces therebetween above said sub-surface, each of said members being adapted to support a section of paving surface and having a plurality of interstices extending downwardly from the surface of the paving between their abutting edges and communicating with the drainage spaces.

1,935,028. **Contraction Joint.** John N. Heltzel, Warren, O. A division strip to be embedded in concrete having a rib pressed therefrom immediately below its upper edge and having its lower edge bent back and extending upwardly to form an elongated open hook, said strip having pockets pressed therefrom, said pockets being distributed throughout the length of the strip between said rib and hook.

NOVEMBER 21, 1933

1,936,209. **Road Building Apparatus.** Albert F. Reiland, Hackettstown, N. J. A road building apparatus comprising a wheeled truck adapted to travel on form wheels, a grader pivotally carried by said truck, means for raising and lowering said grader, and means for presetting the operative depth of said grader, thereby predetermining the thickness of concrete pavement.

1,936,518. **Road Grader.** Joseph H. McColm, Gaston, Ind. A road grader comprising a surface working blade unit and means including a gyroscopic device for automatically maintaining said unit at a set angle during the travel of the grader.

NOVEMBER 28, 1933

1,936,740. **Road Form.** Anthony S. Wolf, Pittsburgh, Pa., assignor to Blaw-Knox Co., Pittsburgh, Pa. In combination, a primary road rail having a flange extending downwardly from the rail head, an auxiliary rail superimposed on the head of the primary rail, and a clamp mechanism for securing the rails to each other in superimposed relationship, said mechanism including a clamp member secured to auxiliary rail and extended rearwardly therefrom, an additional and relatively movable clamp member having a part adjacent the rearward extension of the member first mentioned and a part projecting forwardly therefrom beneath said head and flange of the primary rail, the clamp members being provided with registering apertures, a wedge device extended through said apertures whereby the two members may be moved toward and away from each other, the forward extension of the relatively movable clamp member further being notched to receive said downwardly extending flange, whereby to provide for alignment of the rails upon movement of the wedge device to draw the clamp members toward each other.

DECEMBER 5, 1933

1,937,719. **Roadway Ripper.** Ray C. Sherman, Seattle, Wash., assignor to Isaacson Iron Works. A machine of the character described comprising a ground vehicle including a stationary element, a frame structure hingedly attached to the rear thereof for upward and downward adjustment and having downwardly directed ground working teeth therein, a brace beam connected at one end to the hingedly attached frame and overlying the ground vehicle and having recesses at spaced intervals therealong for application selectively to the stationary element of the ground vehicle to retain the hinged frame at definite positions of adjustment and means for displacing the brace beam from holding connection with the stationary element to permit freedom of movement of the beam for adjustment of the hinged frame.

1,938,023. **Road Treating Apparatus.** Henry A. Ingalls, Bakersfield, Calif. A road treating machine comprising a portable frame adapted to be drawn over the ground, a substantially V shaped member at the front of the frame, vertically adjustable teeth carried by the member, a disk gang carried by the frame and including disks corresponding in number with the aforementioned teeth and arranged in longitudinal alinement therewith, means for raising and lowering the frame, and means carried by the frame and positioned rearwardly of the said gang of disks for following in the furrows formed by the disks and for distributing a soil treating fluid thereto.

DECEMBER 12, 1933

1,938,644. **Pavement and Method of Making the Same.** William E. Swanson, Weehawken, N. J. A pavement as characterized comprising in combination with a foundation, a grid upon said foundation, a cement body within the grid for a portion of the height thereof, said foundation and body having a strong union therebetween rendering the same substantially integral and thereby securing the grid in place immovably, said grid having its several members provided with T-heads thereon, blocks having flared lower peripheries substantially of dimensions equal to the distance between the T-heads of the grid so as to pass therebetween, the upper parts of said blocks having dimensions less than the distance between the T-heads of the grid for leaving space therebetween for sealing purposes, and a filler applied in said spaces between the block overlying the flared portion of the block and underlying the projecting portion of the block and underlying the projecting portion of the T-head for securing the block immovably in place.

1,938,755. **Machine for Refinishing Roads.** Lee Swearingen, Bakersfield, Calif. A machine for finishing roads, including a portable frame, a roller operable by the movement of the machine, a bunker having an outlet, means for expelling material therefrom, a tank, means for expelling material therefrom, a mixer for receiving materials from the expelling means and delivering them into the path of the roller, and separate means operated by the roller for actuating the respective material expelling means thereby to maintain a constant proportion of the two materials within the mixer irrespective of the speed of rotation of the roller and the quantity of materials delivered to the mixer.

1,939,341. **Road Finishing Machine.** Walter S. Edge, Westfield, N. J., assignor, by mesne assignments, to Pittsburgh Steel Co., Pittsburgh, Pa. Apparatus for forming slots in concrete roadways comprising a frame mounted for traveling movement to and fro, a cutting plate connected to the front end of the frame, and a cutting plate connected to the rear end of said frame, in longitudinal alinement with the first-named plate, the said plates being spaced apart and each of short length relative to the length of the frame.

DECEMBER 19, 1933

1,940,417. **Bituminous Pavement.** Alfred S. Hirzel, Wilmington, Del. A bituminous pavement having an upper or wearing course, comprising a bituminous binder and a mineral aggregate consisting of stone and slag, the larger particles being stone and the smaller particles constituting less than 50% and more than 10% of the aggregate, being crushed slag.

1,940,645. **Manufacture of Bituminous Paving Material.** Robert P. Fletcher, Jr., Wilmington, Del. The process of manufacturing bituminous pavement which consists in adding to the mineral aggregate first a volatile temporary fluxing oil; and then as a separate addition an ordinary bituminous paving cement; and then as a further addition a bituminous tempering material consisting of a hard powdered asphalt or gilsonite; and mixing these elements and laying the pavement before complete coalescence.

DECEMBER 26, 1933

1,940,898. **Stone and Asphalt Spreader.** Franklin E. Arndt, Galion, Ohio, assignor to The Galion Iron Works & Manufacturing Co., Galion, Ohio. In an asphalt spreader, a strike-off blade, a plurality of brackets associated therewith attached to the rear face thereof, each bracket including a vertical element, blocks slidingly mounted upon the vertical elements of the several frames, a horizontally disposed rake plate having a vertical portion, with which said blocks are engaged and having nuts mounted thereon, the rake plate having depending teeth, the brackets having rearwardly extending elements, and screws mounted in said elements and extending through the nuts whereby the rake plate may be adjusted.